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Yamamoto

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(54) **IMAGE FORMING APPARATUS AND IMAGE FORMING SYSTEM WITH CORRECTION MECHANISM**

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(22) Filed: **Oct. 9, 2015**

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Jun. 5, 2015 (JP) 2015-115097

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G03G 15/00 (2006.01)
G03G 21/00 (2006.01)
B65H 85/00 (2006.01)
B65H 9/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/6564*** (2013.01)

(58) **Field of Classification Search**
CPC ... G03G 15/00; G03G 15/6564; G03G 15/23; G03G 21/00; G03G 21/14; B65H 85/00; B65H 9/00; B65H 9/10
USPC 399/361, 364, 381, 401
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,137,989 A * 10/2000 Quesnel B65H 9/103 347/248
6,813,451 B2 * 11/2004 Wibbels G03G 15/234 399/394
7,770,879 B2 8/2010 Kazama et al.
8,205,878 B2 6/2012 Masuda
8,571,460 B2 * 10/2013 deJong B65H 5/34 271/265.02
2004/0046313 A1 * 3/2004 Herrmann B65H 9/002 271/226
2004/0215411 A1 * 10/2004 Howe B65H 9/106 702/85
2004/0251611 A1 * 12/2004 Rapkin B41J 3/60 271/226
2006/0285903 A1 * 12/2006 Yamane B65H 9/002 399/394
2007/0242997 A1 * 10/2007 Takahashi B41J 3/60 399/395

(Continued)

FOREIGN PATENT DOCUMENTS

JP 10035948 A * 2/1998 ..... G03G 15/00
JP 10310288 A * 11/1998 ..... B65H 9/00

(Continued)

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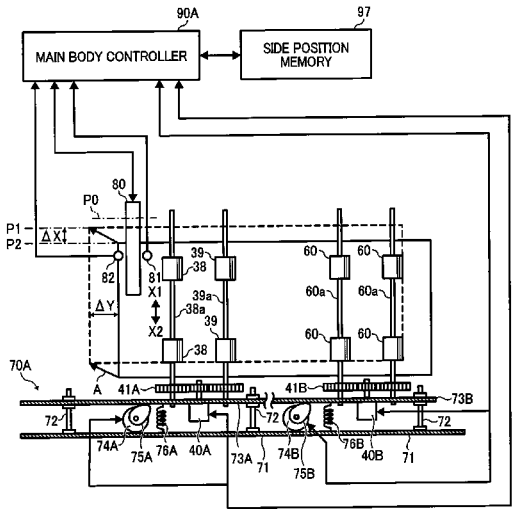
(57) **ABSTRACT**

An image forming apparatus and an image forming system, the image forming apparatus including a memory to store first side position and second side position detected by a side end detector, a correction mechanism to movably support at least a registration roller of a first sheet conveyor and a second sheet conveyor in a direction perpendicular to a sheet conveying direction, and a controller to calculate a deviation between the first side position and the second side position, and to set the deviation as a correction amount of the correction mechanism.

15 Claims, 13 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0264066 A1* 11/2007 Peng G03G 15/5062 399/395
2010/0308532 A1* 12/2010 deJong B65H 5/34 271/227
2011/0049794 A1* 3/2011 Kinoshita B65H 9/002 271/227
2011/0052292 A1* 3/2011 Prabhat G03G 15/6561 399/395
2011/0064499 A1* 3/2011 Johnston B65H 7/14 399/388
2012/0269563 A1* 10/2012 Ui B65H 7/10 399/367
2015/0132016 A1* 5/2015 Aoki G03G 15/6567 399/16
2015/0239687 A1 8/2015 Shinkawa et al.
2015/0249764 A1* 9/2015 Nakatani G03G 15/0131 358/1.5
2015/0378297 A1* 12/2015 Nakura G03G 15/6558 399/395

FOREIGN PATENT DOCUMENTS

JP 2005194016 A * 7/2005 ..... B65H 85/00
JP 2005208406 A * 8/2005 ..... G03G 15/00
JP 2005263463 A * 9/2005 ..... G03G 21/00
JP 2006027859 A * 2/2006 ..... B65H 9/00
JP 2006206195 A * 8/2006 ..... B65H 9/00
JP 2011185976 A * 9/2011 ..... B65H 85/00
JP 2013018653 A * 1/2013 ..... G03G 21/14

* cited by examiner

FIG. 1

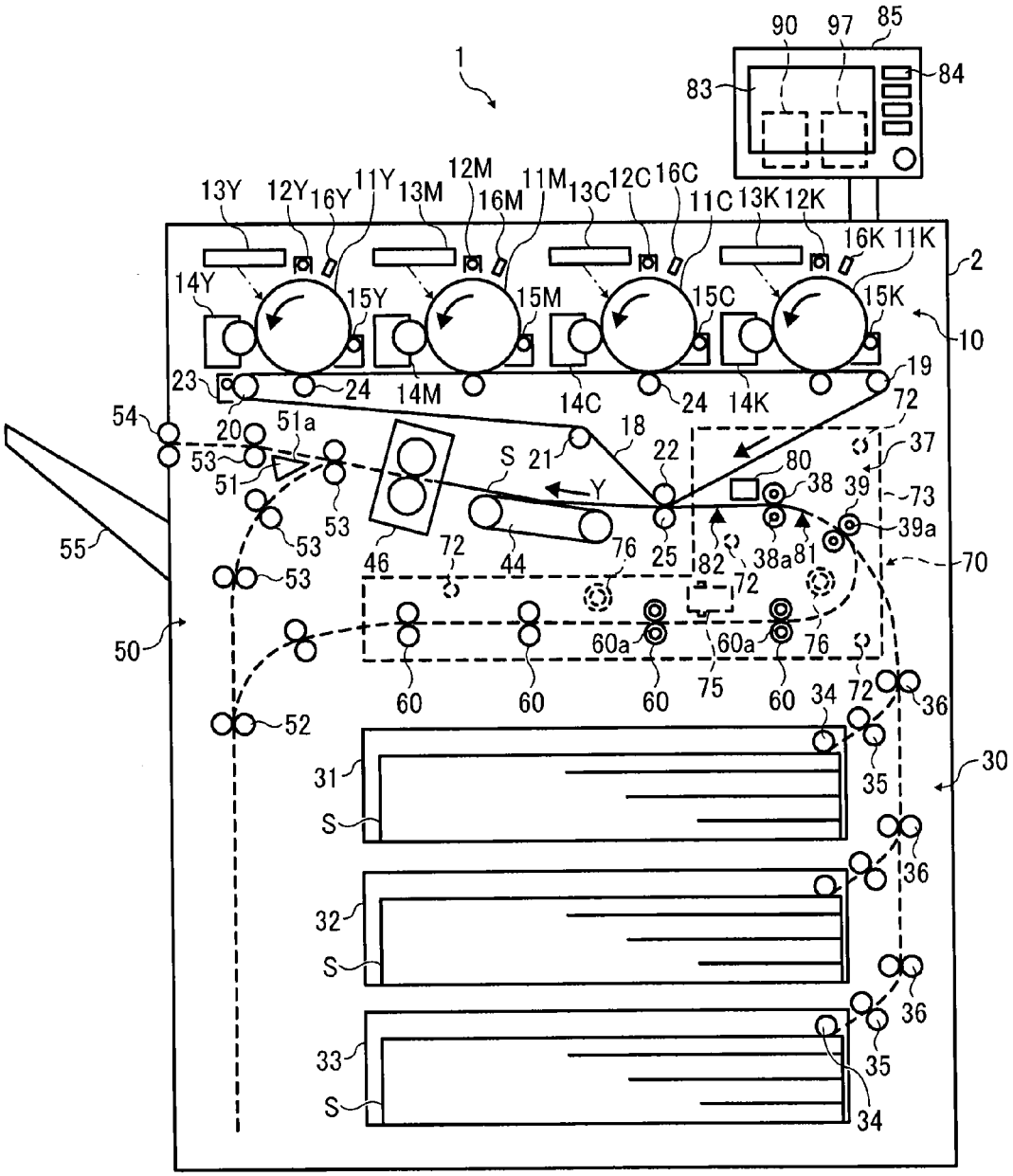

1
90
97
85
83
84
13Y
12Y
16Y
11Y
13M
12M
16M
11M
13C
12C
16C
11C
13K
12K
16K
11K
2
14Y
15Y
15M
15C
15K
10
23
24
14M
14C
24
14K
19
72
54
20
51a
18
37
53
51
S
21
22
80
38
39
73
Y
53
53
39a
55
46
72
44
76
25
82
38a
81
70
53
72
50
60a
60a
76
60
60
60
75
60
34
72
36
52
31
35
30
S
36
32
S
36
33
35
S
34

FIG. 2

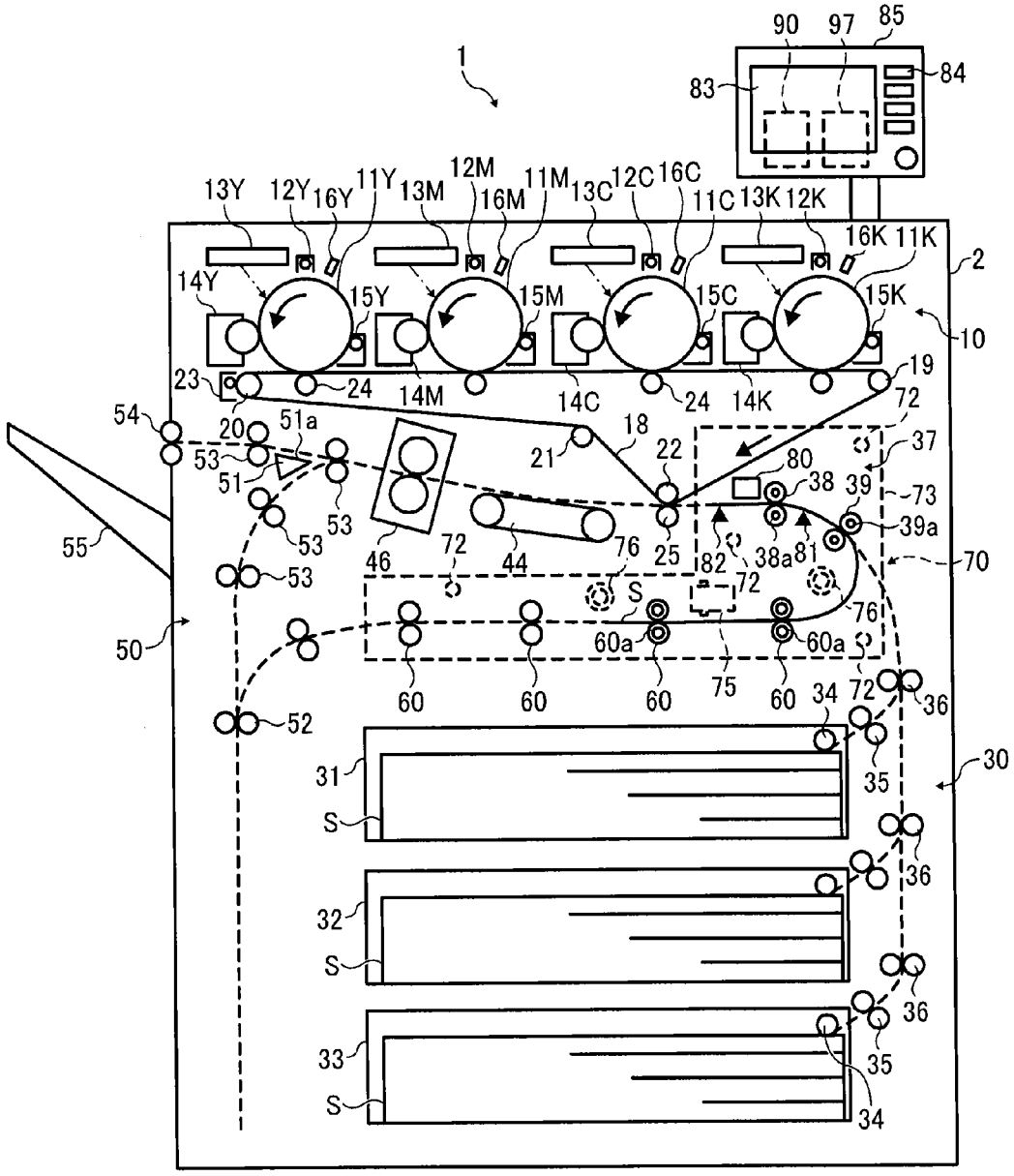

1
90
97
85
83
84
13Y
12Y
16Y
11Y
13M
12M
16M
11M
13C
12C
16C
11C
13K
12K
16K
11K
2
14Y
15Y
15M
15C
15K
10
23
24
14M
14C
24
14K
19
72
54
20
51a
18
21
22
80
37
53
51
38
39
73
53
53
39a
55
46
72
44
76
25
82
38a
81
70
53
S
72
50
60a
60a
76
60
60
60
75
60
34
72
36
52
31
35
30
S
36
32
S
36
33
35
S
34

FIG. 3

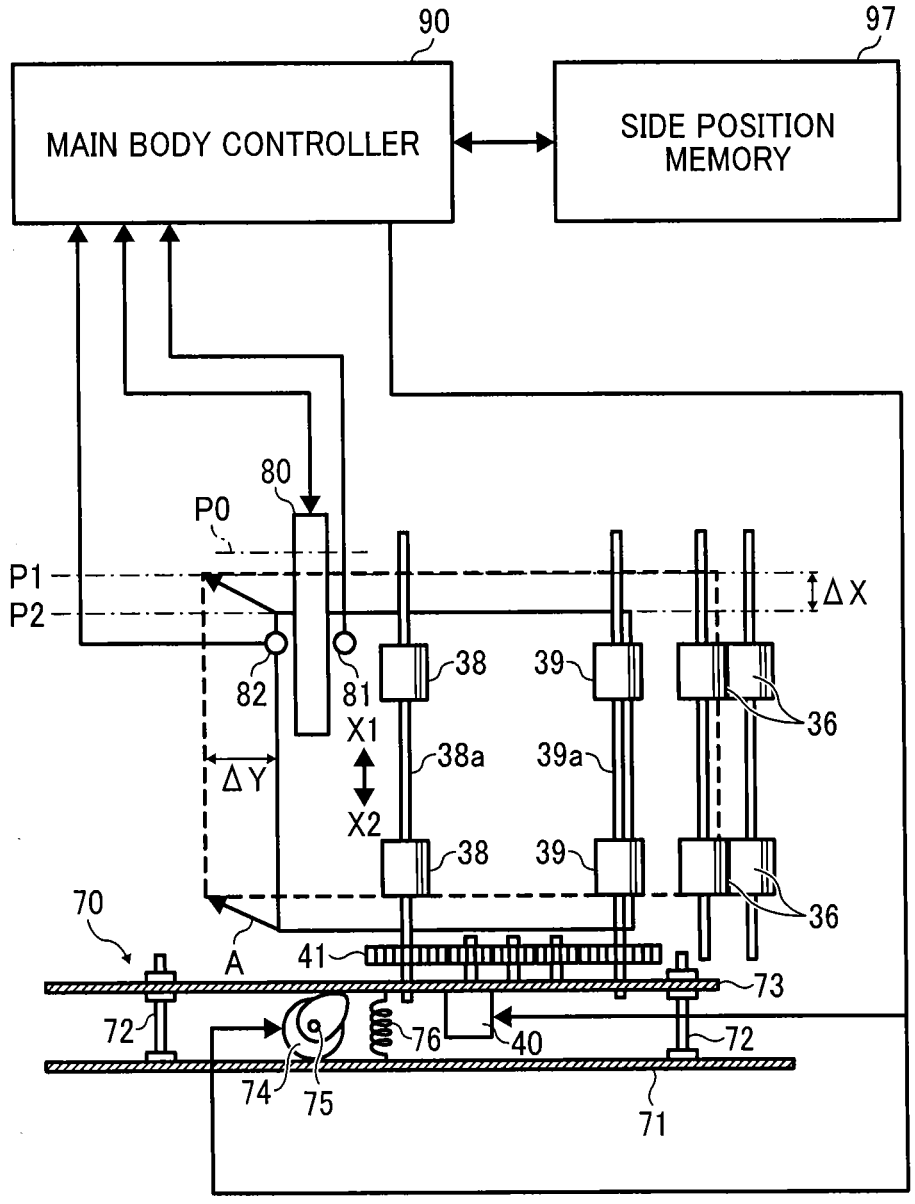

90
97
MAIN BODY CONTROLLER
SIDE POSITION MEMORY
80
P0
P1
P2
ΔX
82
81
38
39
36
X1
38a
39a
ΔY
X2
38
39
36
70
A
41
73
72
76
40
72
74
75
71

FIG. 4

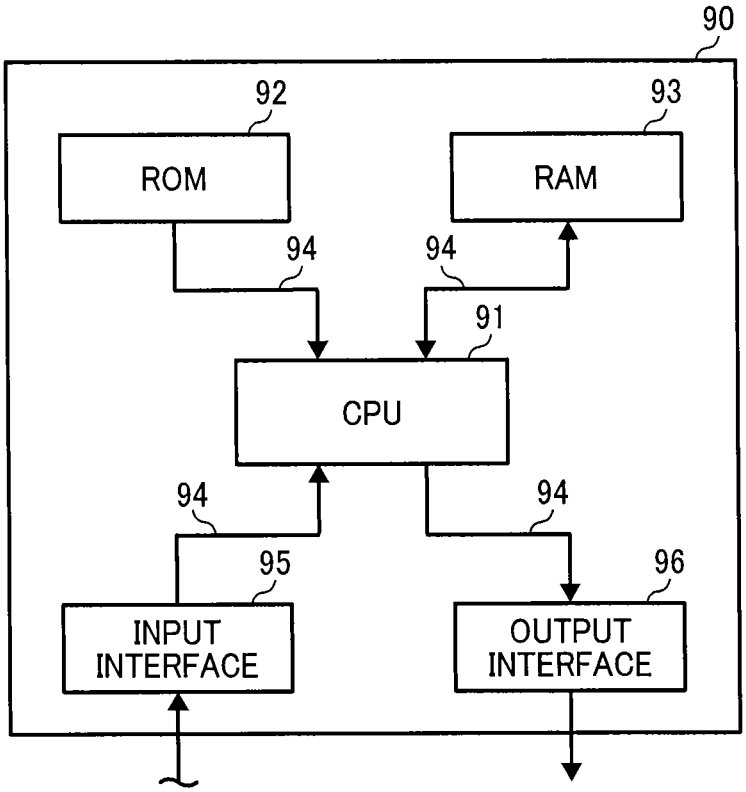

90
92
93
ROM
RAM
94
94
91
CPU
94
94
95
96
INPUT INTERFACE
OUTPUT INTERFACE

FIG. 5

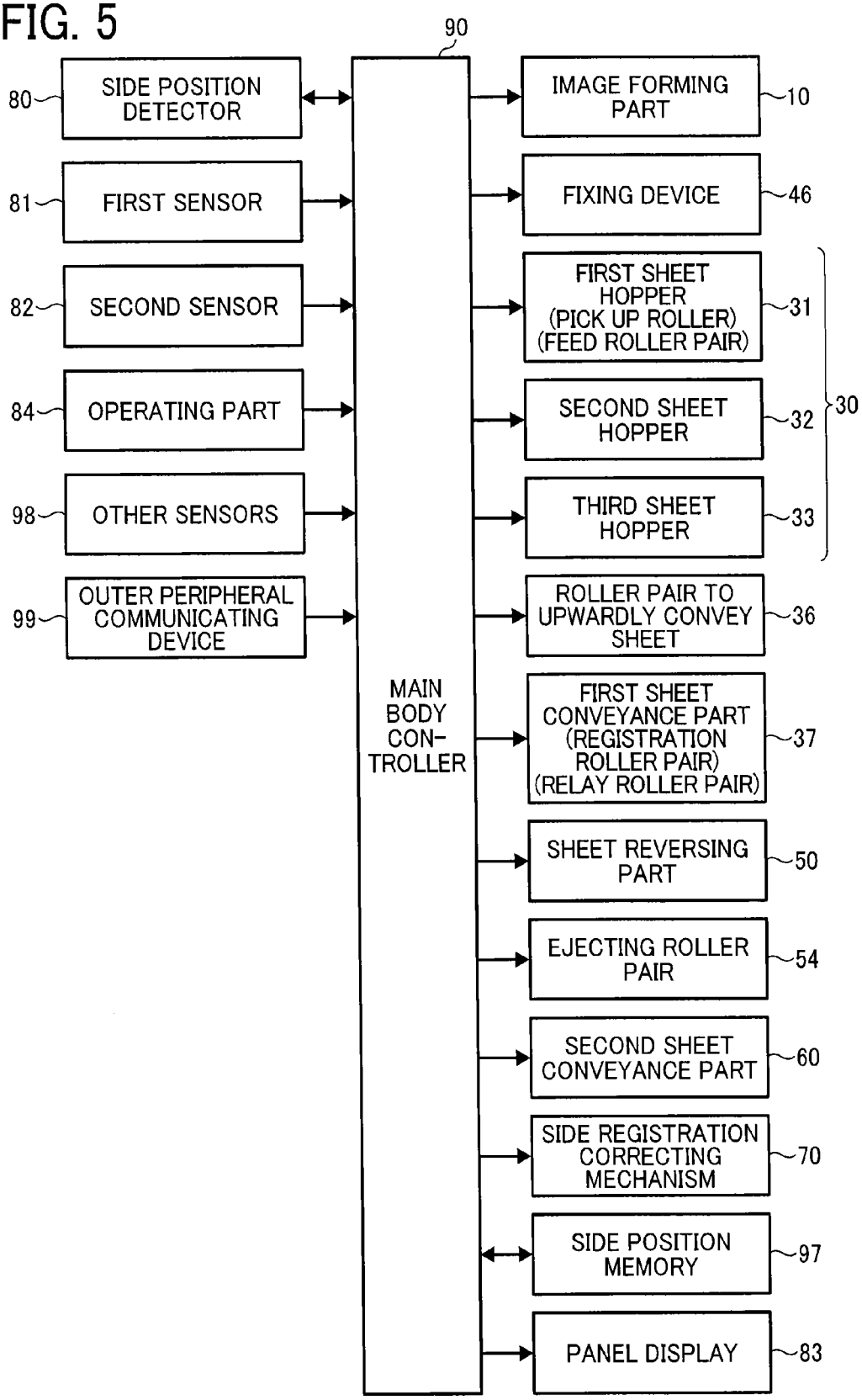

90
80
SIDE POSITION DETECTOR
81
FIRST SENSOR
82
SECOND SENSOR
84
OPERATING PART
98
OTHER SENSORS
99
OUTER PERIPHERAL COMMUNICATING DEVICE
MAIN BODY CON-TROLLER
IMAGE FORMING PART
10
FIXING DEVICE
46
FIRST SHEET HOPPER (PICK UP ROLLER) (FEED ROLLER PAIR)
31
SECOND SHEET HOPPER
32
THIRD SHEET HOPPER
33
30
ROLLER PAIR TO UPWARDLY CONVEY SHEET
36
FIRST SHEET CONVEYANCE PART (REGISTRATION ROLLER PAIR) (RELAY ROLLER PAIR)
37
SHEET REVERSING PART
50
EJECTING ROLLER PAIR
54
SECOND SHEET CONVEYANCE PART
60
SIDE REGISTRATION CORRECTING MECHANISM
70
SIDE POSITION MEMORY
97
PANEL DISPLAY
83

FIG. 6

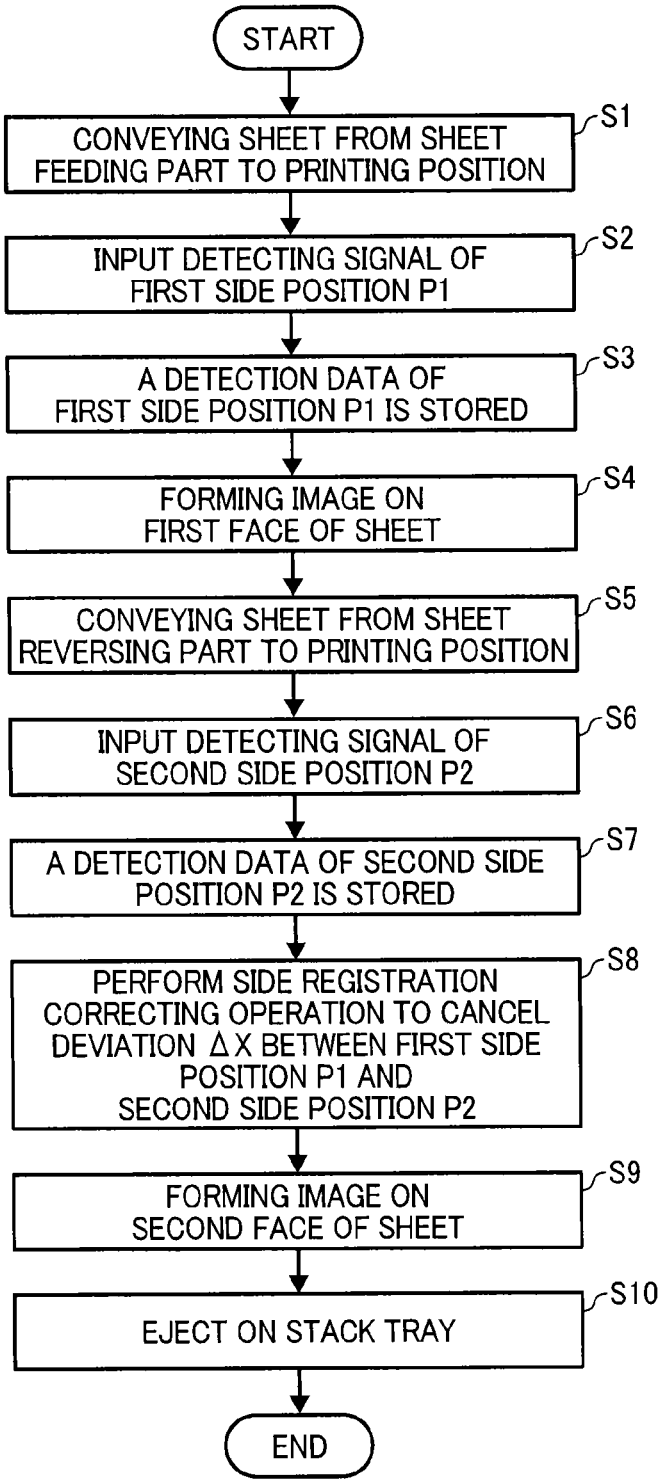

START
CONVEYING SHEET FROM SHEET FEEDING PART TO PRINTING POSITION
S1
INPUT DETECTING SIGNAL OF FIRST SIDE POSITION P1
S2
A DETECTION DATA OF FIRST SIDE POSITION P1 IS STORED
S3
FORMING IMAGE ON FIRST FACE OF SHEET
S4
CONVEYING SHEET FROM SHEET REVERSING PART TO PRINTING POSITION
S5
INPUT DETECTING SIGNAL OF SECOND SIDE POSITION P2
S6
A DETECTION DATA OF SECOND SIDE POSITION P2 IS STORED
S7
PERFORM SIDE REGISTRATION CORRECTING OPERATION TO CANCEL DEVIATION ΔX BETWEEN FIRST SIDE POSITION P1 AND SECOND SIDE POSITION P2
S8
FORMING IMAGE ON SECOND FACE OF SHEET
S9
EJECT ON STACK TRAY
S10
END

FIG. 7

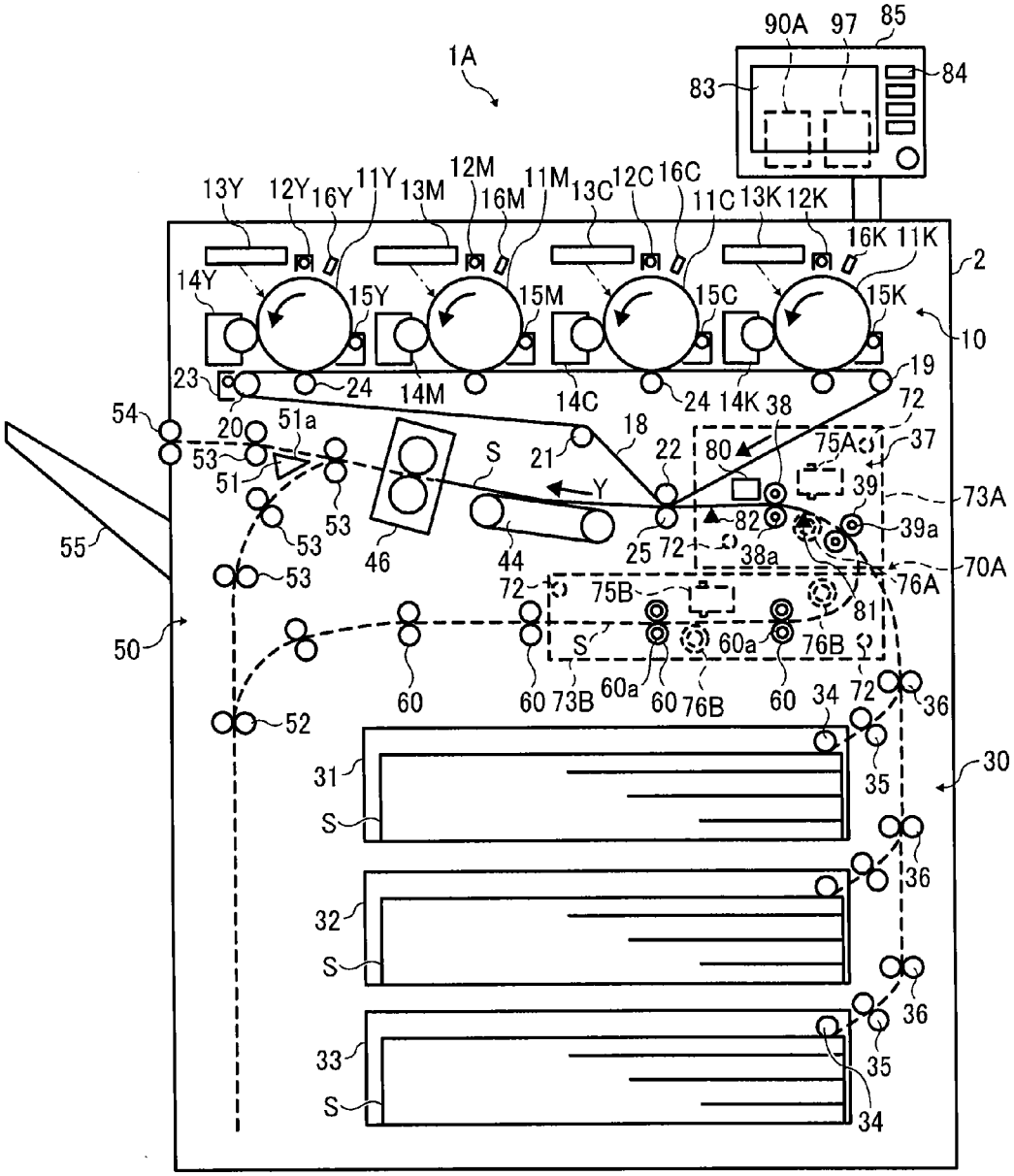

1A
90A
97
85
84
83
13Y
12Y
16Y
11Y
13M
12M
16M
11M
13C
12C
16C
11C
13K
12K
16K
11K
2
14Y
15Y
15M
15C
15K
10
19
23
24
14M
14C
24
14K
38
72
54
20
51a
18
22
80
75A
37
53
51
S
21
Y
39
73A
53
53
46
44
25
72
82
38a
39a
55
53
70A
72
75B
76A
81
50
S
60a
76B
60
60
60
73B
60a
60
76B
60
34
72
36
52
31
S
35
30
36
32
S
36
33
S
35
34

FIG. 8

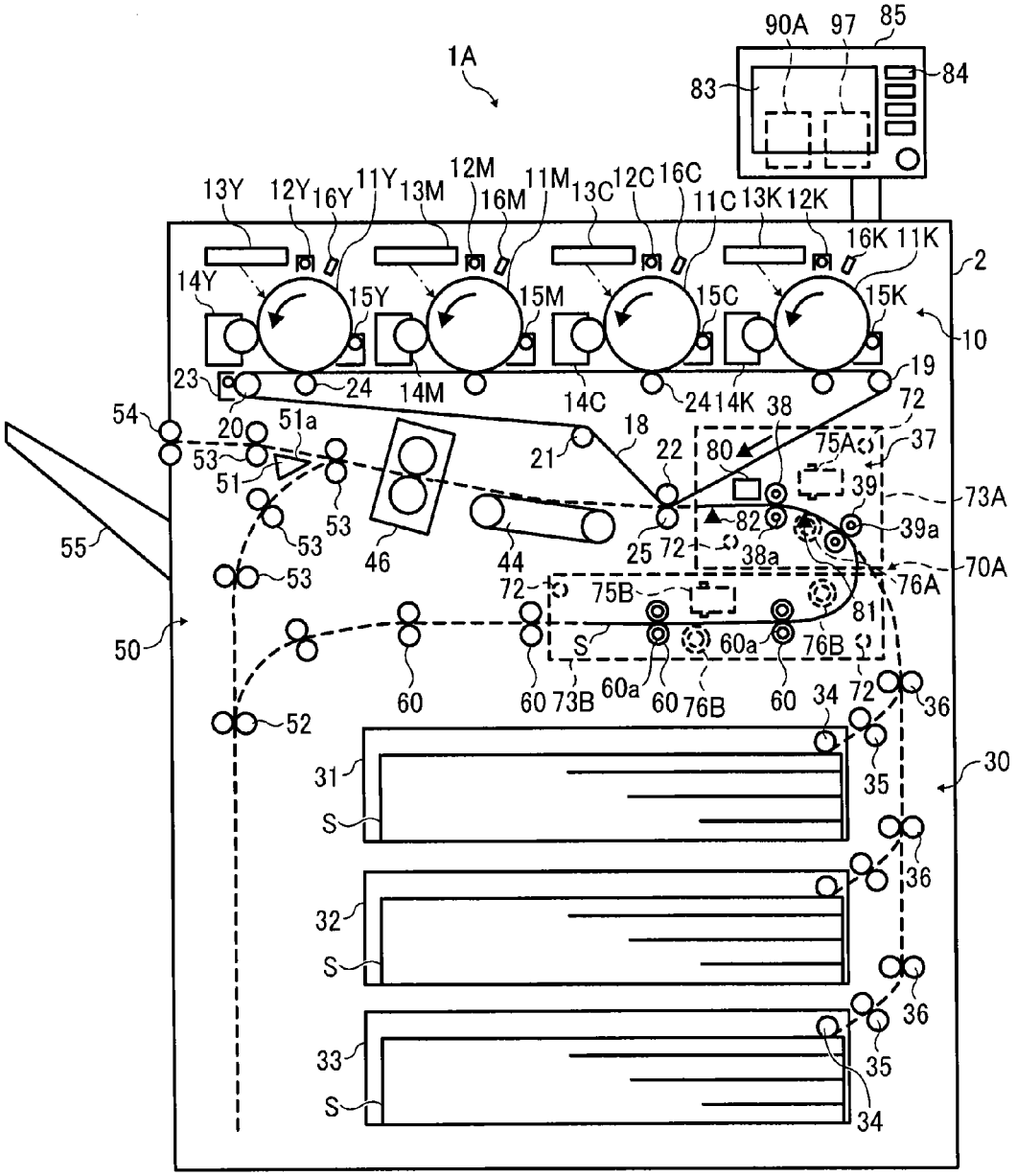
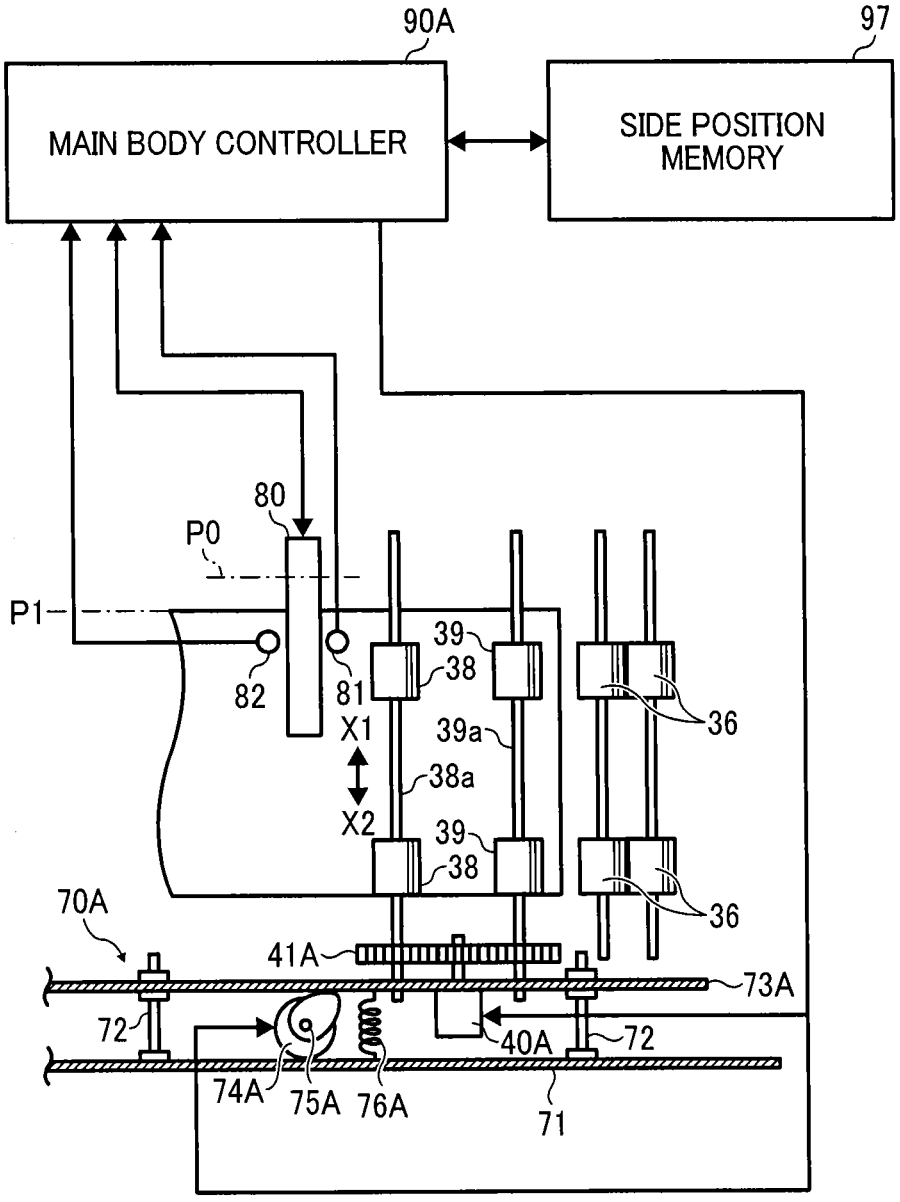

1A
90A
97
85
84
83
13Y
12Y
16Y
11Y
13M
12M
16M
11M
13C
12C
16C
11C
13K
12K
16K
11K
2
14Y
15Y
15M
15C
15K
10
19
23
24
14M
14C
24
14K
38
72
54
20
51a
18
21
22
80
75A
37
53
51
39
73A
53
53
46
44
25
72
82
38a
39a
55
53
70A
72
75B
76A
81
50
S
60a
76B
60
60
73B
60a
60
76B
60
34
72
36
52
31
35
30
S
36
32
S
36
33
35
S
34

FIG. 9


90A
97
MAIN BODY CONTROLLER
SIDE POSITION MEMORY
80
P0
P1
82
81
39
38
39a
38a
X1
X2
36
70A
41A
73A
72
40A
74A
75A
76A
71

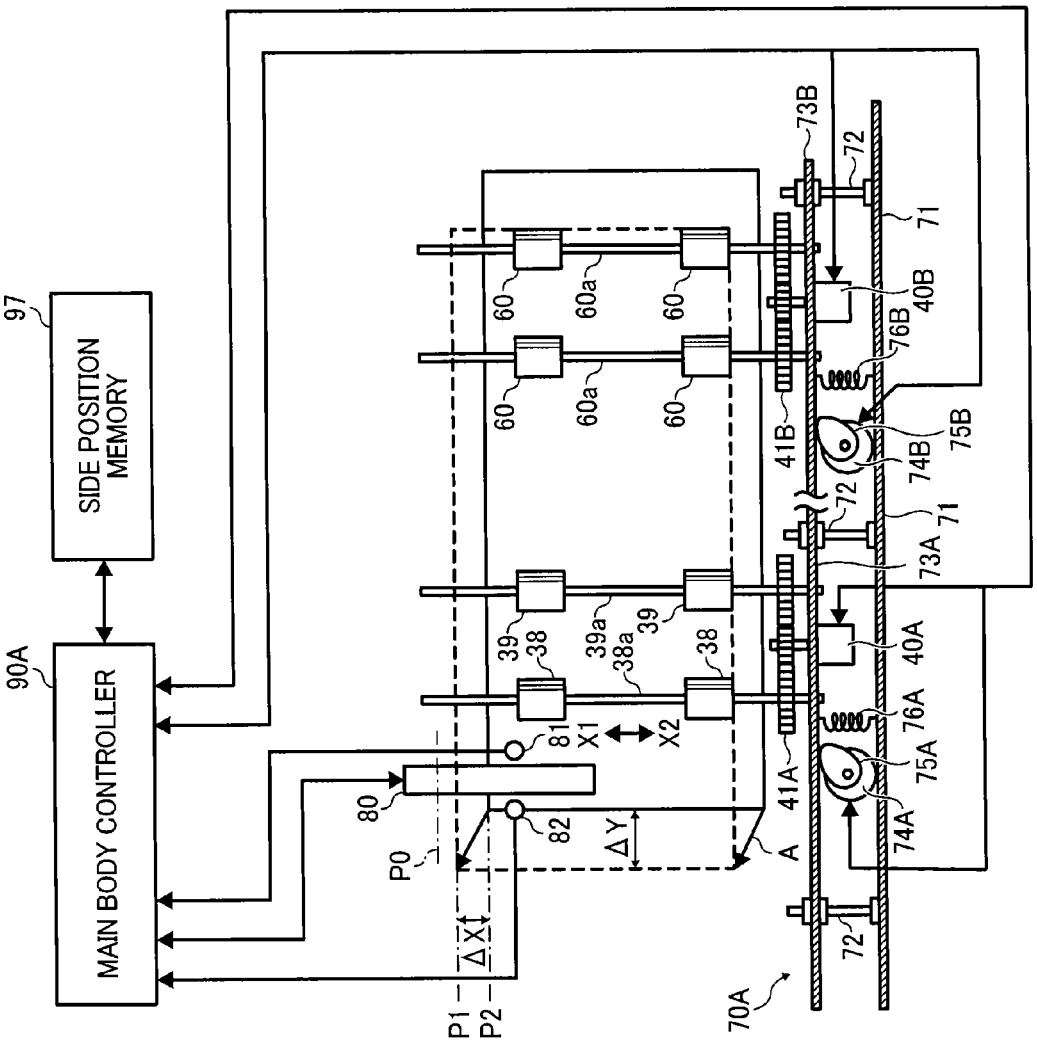

97
SIDE POSITION MEMORY
90A
MAIN BODY CONTROLLER
60
60a
39
38
39a
38a
81
80
82
P0
P1
P2
ΔX
ΔY
X1
X2
A
70A
73B
72
71
40B
76B
41B
74B
75B
73A
40A
76A
41A
75A
74A

FIG. 10

FIG. 11

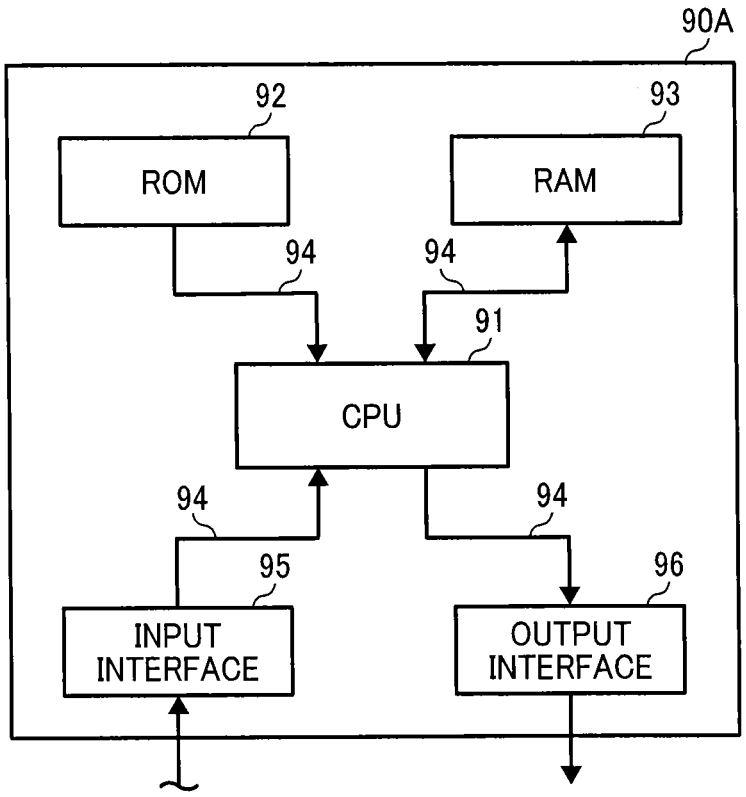

90A
92
93
ROM
RAM
94
94
91
CPU
94
94
95
96
INPUT INTERFACE
OUTPUT INTERFACE

FIG. 12

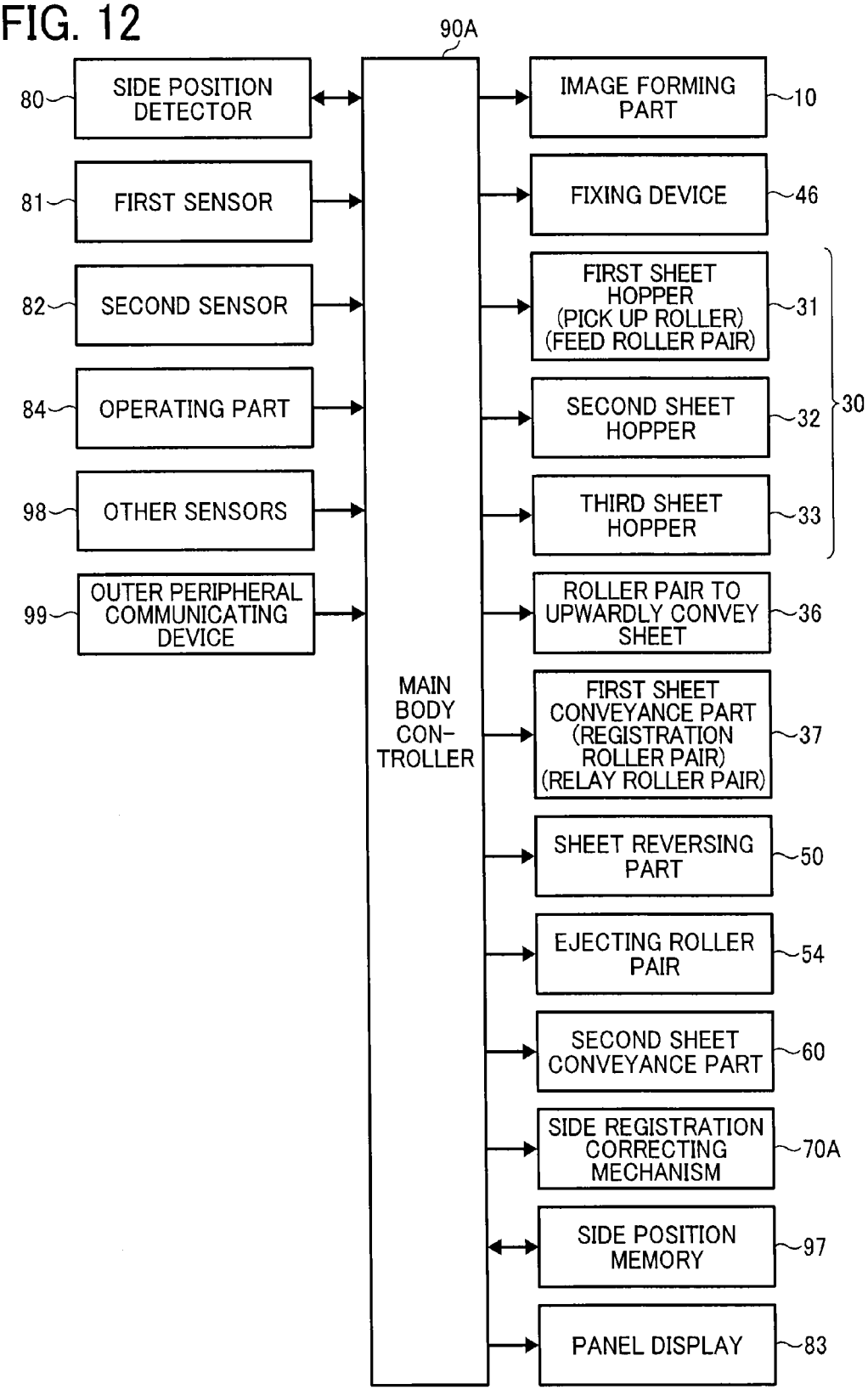

90A
80
SIDE POSITION DETECTOR
81
FIRST SENSOR
82
SECOND SENSOR
84
OPERATING PART
98
OTHER SENSORS
99
OUTER PERIPHERAL COMMUNICATING DEVICE
MAIN BODY CON-TROLLER
IMAGE FORMING PART
10
FIXING DEVICE
46
FIRST SHEET HOPPER (PICK UP ROLLER) (FEED ROLLER PAIR)
31
SECOND SHEET HOPPER
32
THIRD SHEET HOPPER
33
30
ROLLER PAIR TO UPWARDLY CONVEY SHEET
36
FIRST SHEET CONVEYANCE PART (REGISTRATION ROLLER PAIR) (RELAY ROLLER PAIR)
37
SHEET REVERSING PART
50
EJECTING ROLLER PAIR
54
SECOND SHEET CONVEYANCE PART
60
SIDE REGISTRATION CORRECTING MECHANISM
70A
SIDE POSITION MEMORY
97
PANEL DISPLAY
83

FIG. 13

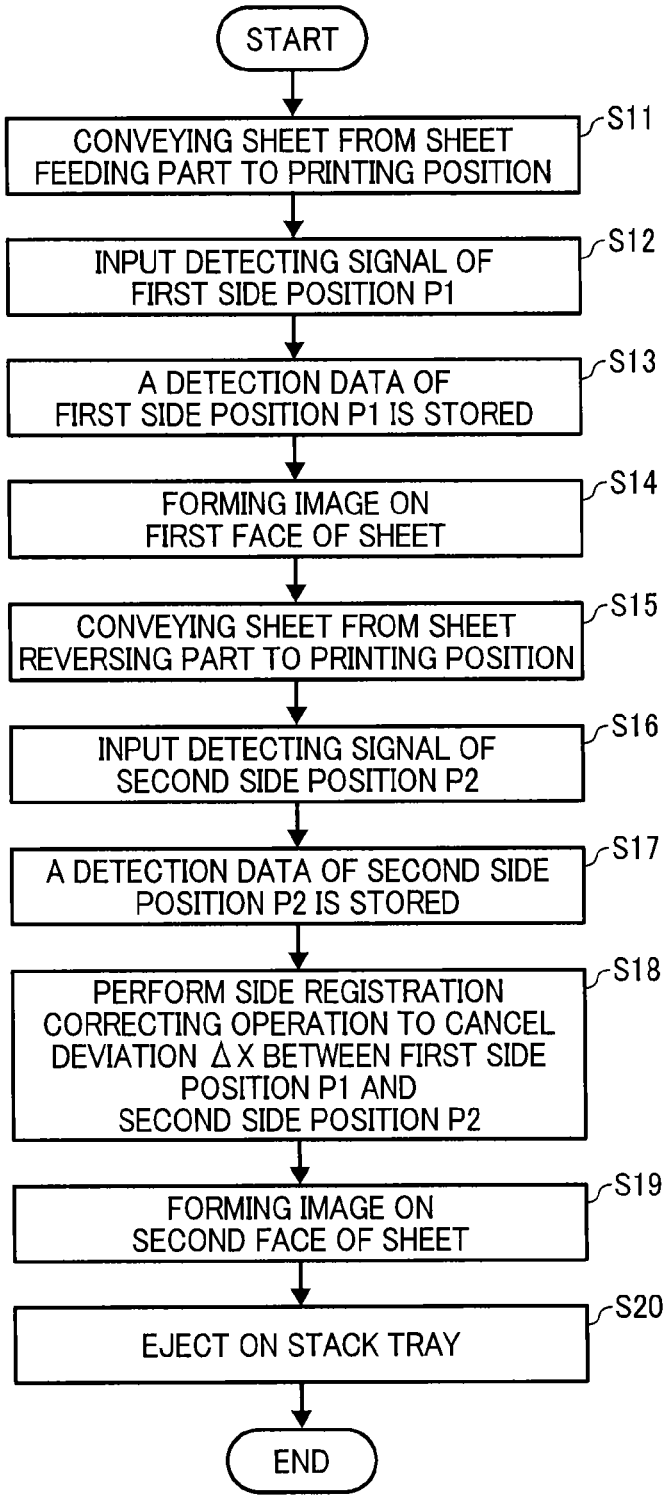

START
CONVEYING SHEET FROM SHEET FEEDING PART TO PRINTING POSITION
S11
INPUT DETECTING SIGNAL OF FIRST SIDE POSITION P1
S12
A DETECTION DATA OF FIRST SIDE POSITION P1 IS STORED
S13
FORMING IMAGE ON FIRST FACE OF SHEET
S14
CONVEYING SHEET FROM SHEET REVERSING PART TO PRINTING POSITION
S15
INPUT DETECTING SIGNAL OF SECOND SIDE POSITION P2
S16
A DETECTION DATA OF SECOND SIDE POSITION P2 IS STORED
S17
PERFORM SIDE REGISTRATION CORRECTING OPERATION TO CANCEL DEVIATION ΔX BETWEEN FIRST SIDE POSITION P1 AND SECOND SIDE POSITION P2
S18
FORMING IMAGE ON SECOND FACE OF SHEET
S19
EJECT ON STACK TRAY
S20
END

IMAGE FORMING APPARATUS AND IMAGE FORMING SYSTEM WITH CORRECTION MECHANISM

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application is based on and claims priority pursuant to 35 U.S.C. §119(a) to Japanese Patent Application No. 2014-209201, filed on Oct. 10, 2014, and to Japanese Patent Application No. 2015-115097, filed on Jun. 5, 2015 in the Japan Patent Office, the entire disclosure of each of which is hereby incorporated by reference herein.

BACKGROUND

1. Technical Field

The present disclosure relates to an image forming apparatus and an image forming system which includes a duplex printing mode. The image forming apparatus and the image forming system include, for example, a copier, a printer, a facsimile machine, or a multifunction peripheral having at least two of copying, printing, facsimile transmission, plotting, and scanning capabilities.

2. Description of the Related Art

Image forming apparatus such as printers, digital copiers, facsimiles and multifunctional peripherals (capable of serving at least two of the following functions: printer, copier and facsimile), generally include a sheet feeding device, a sheet conveyance device and an image forming unit. The sheet feeding device feeds a sheet to a sheet conveyance path. The sheet conveyance device conveys the sheet along the sheet conveyance path. The image forming unit outputs an image on the sheet. The sheet conveyance path of the sheet conveyance device includes a plurality of conveyance rollers thereon. The conveyance rollers are rotationally driven by drive sources such as motors to convey the transfer sheet.

Such image forming apparatuses can be provided with a registration device which adjusts the sheet position relative to an image position in a direction perpendicular to a sheet conveying direction. The sheet position in the direction needs to be corrected at an upstream side from a position in which the image is output on the sheet so that the image can be formed on an accurate position of the sheet in the direction. This correction of position in the direction is hereinafter referred to as a side registration correcting operation.

It is an object of the present disclosure to accurately correct relative positions of images formed on both faces of a sheet when the image forming apparatus includes a duplex printing mode.

SUMMARY

An image forming apparatus that includes a sheet feeder, including a roller, to feed a sheet to a sheet conveyance passage, an image former, including a transfer belt, to form an image on the sheet, a first sheet conveyor, including a registration roller, at an upstream side of an image forming position in which the image former forms the image on the sheet, to convey the sheet along a sheet conveying direction, a sheet reverser, including a guiding roller, to reverse the sheet on which the image is formed on a first face, a second sheet conveyor, including a conveying roller, to convey the sheet, which is reversed by the sheet reverser, to the first sheet conveyor, a side end detector disposed near the first sheet conveyor to detect a first side position and a second side position, a memory to store the first side position and the second side position detected by the side end detector, a correction mechanism, including a movable plate, to movably support at least the registration roller of the first sheet conveyor and the second sheet conveyor in a direction perpendicular to the sheet conveying direction, and a controller to calculate a deviation between the first side position and the second side position, and to set the deviation as a correction amount of the correction mechanism. The first side position is a side end position of the first face of the sheet and the second side position is a side end position of the second face of the sheet, and, in a side registration correcting operation, the controller controls movement of the correction mechanism by the correction amount.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

A more complete appreciation of the disclosure and many of the intended advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings.

FIG. **1** is a schematic cross-sectional view of an image forming apparatus according to a first embodiment in one state of an operation;

FIG. **2** is a schematic cross-sectional view of the image forming apparatus illustrated in FIG. **1** in another state of the operation;

FIG. **3** is a schematic plan view of a side registration correcting mechanism of the image forming apparatus illustrated in FIG. **1** which includes a block diagram;

FIG. **4** is a block diagram of a main body controller of the image forming apparatus in the first embodiment;

FIG. **5** is a block diagram of an overall image forming apparatus in the first embodiment;

FIG. **6** is a schematic flowchart of a side registration correcting operation which the main body controller of the image forming apparatus in the first embodiment performs in a duplex printing mode;

FIG. **7** is a schematic cross-sectional view of an image forming apparatus according to a second embodiment is in one state of an operation;

FIG. **8** is a schematic cross-sectional view of the image forming apparatus illustrated in FIG. **7** in another state of the operation;

FIG. **9** is a schematic plan view of a side registration correcting mechanism of the image forming apparatus illustrated in FIG. **7** which includes a block diagram for explaining a side registration correcting operation in printing a first face of a duplex printing;

FIG. **10** is a schematic plan view of a side registration correcting mechanism of the image forming apparatus illustrated in FIG. **7** which includes a block diagram for explaining the side registration correcting operation in printing a second face of the duplex printing;

FIG. **11** is a block diagram of the main body controller of the image forming apparatus in the second embodiment;

FIG. **12** is a block diagram of the image forming apparatus in the second embodiment; and

FIG. **13** is a schematic flowchart of the side registration correcting operation which the main body controller of the image forming apparatus in the second embodiment performs in the duplex printing mode.

DETAILED DESCRIPTION

Various embodiments will be described below with reference to the accompanying drawings. In the descriptions of the

embodiments, the same components or components with the same functions are denoted by the same reference symbols, and the same explanation will not be repeated in subsequent embodiments. The descriptions below are mere examples and do not limit the scope of the appended claims. Further, a person skilled in the art may easily conceive other embodiments by making modifications or changes within the scope of the appended claims; however, such modifications and changes obviously fall within the scope of the appended claims. In the drawings, Y, M, C, and K are symbols appended to components corresponding to yellow, magenta, cyan, and black, respectively, and will be omitted appropriately.

Referring now to the drawings, a four tandem type printer including an intermediate transfer system serving as an image forming apparatus according to an embodiment is described below.

First Embodiment

Referring to FIG. **1** through FIG. **3**, the printer **1** serving as an image forming apparatus according to a first embodiment includes, inside a casing **2**, an image forming part (image former) **10**, a sheet feeding part (sheet feeder) **30**, a first sheet conveyance part (first sheet conveyor) **37**, a fixing device **46**, a sheet reversing part (sheet reverser) **50**, and a second sheet conveyance part (second sheet conveyor) **60**.

Further, the printer **1** includes a plurality of characteristic parts, which include a side registration correcting mechanism **70** serving as a correction mechanism, a side position detector **80** serving as a side end detector, and a main body controller **90** serving as a controller. The image forming part **10** includes four colors of image forming stations. These configurations are explained more specifically below.

Referring to FIG. **1**, the image forming part **10** includes photoconductors **11**Y, **11**M, **11**C, **11**K serving as image bearers corresponding to four colors which are disposed along an upper surface of an intermediate transfer belt **18**. Further, the image forming part **10** includes toner image forming parts **12** (**12**Y, **12**M, **12**C, **12**K), **13** (**13**Y, **13**M, **13**C, **13**K), **14** (**14**Y, **14**M, **14**C, **14**K), **15** (**15**Y, **15**M, **15**C, **15**K), **16** (**16**Y, **16**M, **16**C, **16**K) which are forming visible images for each color, an intermediate transfer belt **18** serving as an intermediate transfer medium which is transferred the visible images from each of the photoconductors **11**Y, **11**M, **11**C, **11**K, and a secondary transfer roller **25** which transfers a layered image, that is layered four colors of visible images, on a sheet S serving as a recording medium.

The toner image forming parts **12**, **13**, **14**, **15**, **16** are arranged in a rotational direction of the photoconductor **11** in this order. And, the toner image forming parts **12**, **13**, **14**, **15**, **16** are, for example explained in the Yellow station representative of other colors, a charging device **12** serving as a charger which takes a charge to a surface of the photoconductor **11**, a laser scanning device **13** serving as an exposing device, a developing device **14**, a cleaning device **15** to clean a remaining toner on the surface of the photoconductor **11** after transferring, and a quenching lamp **16** serving as a neutralizer which neutralizes a charged surface of the photoconductor **11**. In the other color stations includes the same configuration as the Yellow station. And each of primary transfer rollers **24** pushes the intermediate transfer belt **18** toward each of the photoconductors **11** corresponding to each of primary transfer rollers **24**.

The intermediate transfer belt **18** is seamless and is wound around a first roller **19**, a second roller **20**, a third roller **21**, and a fourth roller **22** serving as a plurality of support members and moves the rollers **19**-**22** around. A cleaning device **23** of the intermediate transfer belt **18** is disposed at the position facing the second roller **20**. The secondary transfer roller **25**, which is driven, is disposed below the fourth roller **22** and pushes the sheet S toward the intermediate transfer belt **18**.

A belt conveyor **44** is disposed at a downstream side of the secondary transfer roller **25** in a sheet conveying direction. Further a fixing device **46** fixes the visible toner image on the sheet S and is disposed at the downstream side of the belt conveyor **44** in the sheet conveying direction.

Accordingly, each color of the four toner images is formed on each of the surfaces of the photoconductors **11**Y, **11**M, **11**C, **11**K, and the four toner images are transferred on an outer surface of the intermediate transfer belt **18** by a primary transferring. As a result of the primary transferring, the four toner images are layered on the outer surface of the intermediate transfer belt **18**. The layered image including four colors of toner images is transferred on the sheet S by a secondary transferring. After that the layered image on the sheet S is fixed by heating and pressing of the fixing device **46**. A printing operation of the image forming apparatus is performed in this sequence.

The sheet feeding part **30** includes first, second, and third sheet hoppers **31**, **32**, **33** which are vertically disposed at a bottom side of the casing **2**, and includes a plurality of roller pairs **36** serving as a vertical sheet conveyor which takes over the sheet S from one of the sheet hoppers, upwardly conveys the sheet S, and transfers the sheet S to a first sheet conveyance part **37**. Each of the sheet hoppers includes a pick-up roller **34** which picks up a single sheet from the sheet hopper. The sheet S is not limited to plain paper, and may include thick paper, a postcard, an envelope, thin paper, coated paper, art paper, tracing paper, or the like. The sheet S may be an OHP (Over-Head Projector) sheet, an OHP films, or the like. In other words, the sheet S may be any type of recording medium capable of carrying an image thereon.

A user who operates the printer **1** selects one of sheet hoppers **31**, **32**, **33** which accommodates a preferred sheet for the user via the main body controller **90** or an input terminal such as a personal computer which is connected to a network and which is constructed in a system. Thereby, a sheet S which is accommodated in the selected one of sheet hoppers **31**, **32**, **33** is conveyed upwardly to the first sheet conveyance part **37** which is disposed on a downstream side in the sheet conveying direction.

An image forming position where the layered image on the intermediate transfer belt **18** is transferred to the sheet S is, in other words, a secondary transferring position where the secondary transfer roller **25** and the intermediate transfer belt **18** form a contact nip. The first sheet conveyance part **37** is disposed on an upstream side relative to the secondary transferring position in the sheet conveying direction and is on the virtual surface which extends horizontally from the contact nip. The first sheet conveyance part **37** includes a registration roller pair **38** and a relay roller pair **39** which is disposed on an upstream side relative to the registration roller pair **38** in the sheet conveying direction.

The registration roller pair **38** and the relay roller pair **39** are configured to rotate intermittently, and to sequentially receive the sheet S which is sequentially conveyed from the plurality of roller pairs **36**, and to convey along the sheet conveying direction toward the secondary transferring position.

A sheet reversing part **50** includes a plurality of guiding roller pairs **53**, a bifurcating claw **51**, and a switch back roller pair **52**. The plurality of guiding roller pairs **53** is disposed downstream side relative to the fixing device **46** in the sheet conveying direction. A part of the plurality of guiding roller

pairs **53** is arranged almost horizontally and the other part of the plurality of guiding roller pairs **53** is arranged almost vertically downward the fixing device **46**. The bifurcating claw **51** is disposed at a position just downstream of a most upstream one of the plurality of guiding roller pairs **53** in the sheet conveying direction. The switch back roller pair **52** is disposed downwardly relative to a most downward one of the plurality of guiding roller pairs **53**.

The switch back roller pair **52** is configured to intermittently rotate, corresponding to a conveyance of the sheet S, in one rotational direction and in another rotational direction. The plurality of guiding roller pairs **53** is configured to rotate intermittently corresponding to a conveyance of the sheet S.

The bifurcating claw **51** is formed in a wedge-shape by an upper inclined surface and a lower inclined surface thereof. An end portion **51***a* which is a tip portion of the wedge-shape faces upstream side in the sheet conveying direction. The bifurcating claw **51** is configured to move the end portion **51***a* up and down by an actuator. In the simplex printing mode, the end portion **51***a* of the bifurcating claw **51** is moved down by the actuator. Then, the end portion **51***a* is positioned below (or lower) relative to a sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction.

Accordingly, the sheet S is conveyed over the upper inclined surface of the bifurcating claw **51** and toward the plurality of guiding roller pairs **53** and an ejecting roller pair **54** at the downstream in the sheet conveying direction. The sheet S is ejected on a stack tray **55** by the ejecting roller pair **54**.

Meanwhile, in the duplex printing mode, the end portion **51***a* is positioned higher relative to the sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction until printing a first face of a duplex printing is finished. The end portion **51***a* is positioned below (or lower) relative to the sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction until printing a second face of a duplex printing is finished.

Accordingly, after printing a first face of a duplex printing, the sheet S is conveyed under the lower inclined surface of the bifurcating claw **51** and toward the switch back roller pair **52**. Before the sheet S passes through the switch back roller pair **52**, the switch back roller pair **52** stops to rotate, and then, the switch back roller pair **52** starts to rotate in the counter direction. Consequently, the sheet S which is upside down is conveyed horizontally toward a second sheet conveyance part **60**. Further, after printing a second face of a duplex printing, in the same manner as the simplex printing mode, the end portion **51***a* is positioned below (or lower) relative to the sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction.

The second sheet conveyance part **60** includes a plurality of conveying roller pairs (hereinafter, referred to as "a conveying roller pair **60**") which is arranged along a sheet conveyance surface parallel to a sheet conveyance surface formed at the contact nip of secondary transferring, which is disposed lower than the contact nip, and which is configured to rotate intermittently.

The plurality of conveying roller pairs **60** receives the sheet S which is reversed from the switch back roller pair **52** and conveys so as to pass the sheet S to the first sheet conveyance part **37** which includes the registration roller pair **38** and the relay roller pair **39**.

Consequently, in the simplex printing mode, the sheet S in the selected one of sheet hoppers **31**, **32**, **33** is picked up by the pick-up roller **34** and the feed roller pair **35** and is conveyed upwardly by the plurality of roller pairs **36**.

Subsequently, the sheet S is conveyed by the relay roller pair **39** and the registration roller pair **38** toward the contact nip and is pressed by the secondary transfer roller **25** at the contact nip with the intermediate transfer belt **18** and the layered image including four colors of toner images is transferred on the intermediate transfer belt **18** by the secondary transferring. After that, the layered image on the sheet S is fixed by the fixing device **46** and the sheet S is ejected on the stack tray **55**.

Meanwhile, in the duplex printing mode, in the same manner as the simplex printing mode, at first, the sheet S is printed on the first face (see FIG. **1**), after that, the sheet S is reversed by the sheet reversing part **50** and is subsequently conveyed by the plurality of conveying roller pairs **60**. Next, the sheet S is subsequently conveyed by the first sheet conveyance part **37** which includes the relay roller pair **39** and the registration roller pair **38** (see FIG. **2**).

After that, similar to the simplex printing mode described above, the second face of the duplex printing is transferred (the layered image including four colors of toner images) on the intermediate transfer belt **18** by the secondary transferring. After that, the layered image on the second face is fixed by the fixing device **46** and the sheet S is ejected on the stack tray **55**.

FIG. **4** is a block diagram of the main body controller **90** of the printer **1**, and FIG. **5** is a block diagram of the overall printer **1**. The main body controller **90** serves as a controller in the present disclosure.

As illustrated in FIG. **4**, the main body controller **90** includes a CPU **91** (Central Processing Unit), a ROM **92** (Read Only Memory) which stores fixed data, a RAM **93** (Random Access Memory) which stores temporary data, a INPUT interface **95**, and a OUTPUT interface **96**.

The ROM **92** stores programs for which the CPU **91** performs operations. The RAM **93** functions as a work area which is used by the CPU **91** when the CPU **91** performs operations. The main body controller **90** can include communication capabilities. The main body controller **90** is configured to entirely control the operations in the printer **1**.

For example, the ROM **92**, serving as a memory, stores a program that is used for controlling the printer **1** including the side registration correcting operation in the first embodiment. The CPU **91** is configured to perform an arithmetic processing based on the program which is stored in the ROM **92**. The RAM **93** is configured to temporary store a result of the arithmetic processing of the CPU **91**, data which is input from an operating part **84** (described later), and etc.

The CPU **91**, the ROM **92**, and the RAM **93** are connected with each other via a bus **94** and are connected with the INPUT interface **95** and the OUTPUT interface **96**.

As illustrated in FIG. **4** and FIG. **5**, the INPUT interface **95** in the main body controller **90** is connected with a side position detector **80** (side end detector), a first sensor **81**, a second sensor **82**, the operating part **84**, other sensors **98**, and an outer peripheral communicating device **99**. The INPUT interface **95** receives detection signals and instruction signals from the devices with which the INPUT interface **95** is connected.

The OUTPUT interface **96** in the main body controller **90** is connected with each of the following object parts: the image forming part **10**, the fixing device **46**, the sheet feeding part which includes first, second, and third feeding hoppers **31**, **32**, **33**, the roller pair **36**, the first sheet conveyance part **37**, the sheet reversing part **50**, the ejecting roller pair **54**, the

second sheet conveyance part **60**, the side registration correcting mechanism **70**, and a side position memory **97** (side end memory). Further, the OUTPUT interface **96** is connected with a panel display **83**.

The side position memory **97** is also connected with the INPUT interface **95**. The main body controller **90** is configured to perform an arithmetic processing based on the detection signals which are inputted via the INPUT interface **95**, and is configured to perform various operations, which corresponds to operations of each of the object parts, via the OUTPUT interface **96**.

The side position memory **97** includes a nonvolatile memory and is configured to store position data which includes a position P1 of side end of sheet in a first face and a position P2 of side end of sheet in a second face. The side position memory **97** can be included in the main body controller **90**.

In a configuration in which a length along the sheet conveyance passage between the feed roller pair **35** and the secondary transfer roller **25** (as a printing position) is longer than a length of a maximum sheet used in the image forming apparatus, and which has a plurality of conveying rollers disposed along the sheet conveyance passage, all of the plurality of conveying rollers would have to be shift rollers or the plurality of conveying rollers would have to partly include separation rollers to be able to move. However, it is not possible to move the sheet in a direction perpendicular to the sheet conveying direction because all of the rollers are not shift rollers or separation rollers.

For this reason, the length along the sheet conveyance passage between the feed roller pair **35** and the secondary transfer roller **25** should be longer. Consequently, the width of the machine becomes larger corresponding to the length of the sheet conveyance passage. Recently, the maximum size of the sheet used in the image forming apparatus is often bigger, such as SRA3 or 13"×19".

Further, the width of the machine usually depends on a size of the image forming part **10** (including transfer device and fixing device) and on a layout of the image forming part **10**, because the size and the layout of the image forming part **10** affect the quality of the output image, the durability, and the printing speed. For this reason, it is difficult to shorten the sheet conveyance passage, without also changing the image forming part **10**.

For these reasons, it is difficult to mount the side registration correcting mechanism **70** into the image forming apparatus, when the width of the machine is small.

Recently, high accuracy of the image position in the field of the light-production printing is required. The term of "high accuracy of the image position" includes two meanings, one is that an absolute position of the image on each face of each sheet, the other is that a relative position of the images on both faces of each sheet.

In the first embodiment, as illustrated in FIG. **1**, an input display device **85** is disposed above the casing **2** of printer **1**. The input display device **85** includes a panel display **83**, an operating part **84**, the main body controller **90**, and the side position memory **97**.

In the first embodiment, there is a characteristic to perform a side registration correction in the duplex printing mode. The side registration correction in the first embodiment is described later by referring to FIG. **1** through FIG. **5**.

The meaning of "a side registration correction" is to correct the relative position of the images on both faces of each sheet in the duplex printing mode. In other words, the meaning of "the side registration correction" is to reduce a position difference (deviation) between an image formed on the first face of the sheet and an image formed on the second face of the sheet. In a case that the position difference of the relative positions of images is lower, a position accuracy (two side accuracy) of the relative positions of images is higher. The side registration correction is to be performed only in the duplex printing mode, and not to be performed in the simplex printing mode.

FIG. **3** is a schematic plan view of the side registration correcting mechanism **70** of the printer **1**, which includes the main body controller **90**, and performs an operation of the side registration correction in the duplex printing mode.

As illustrated in FIG. **3**, the side registration correction of the printer **1** in the first embodiment is configured to work by a cooperation of a side registration correcting mechanism **70**, the side position detector **80** (side end detector), the first sensor **81**, the second sensor **82**, and the main body controller **90**.

The side registration correcting mechanism **70** includes a side plate **71**, a plurality of guide **72**, and a movable plate **73** (plate). The side plate **71** is disposed on a side of a sheet conveyance passage where printing is performed, and inside of the casing **2**. The side plate **71** is formed in a vertical face shape along the sheet conveyance passage, and fixed on the side of the sheet conveyance passage. The plurality of guide **72** are configured to guide the movable plate **73** such that the movable plate **73** is parallel to the side plate **71** between the side plate **71** and the sheet conveyance passage. The plurality of guides **72** are fixed to the side plate **71** at one end thereof, and the other end of the side plate **71** protrudes in a direction perpendicular to the sheet conveying direction.

Further, the side registration correcting mechanism **70** includes a rotary actuator **74**, a cam **75** (eccentric cam), and a plurality of springs **76**. The rotary actuator **74** is fixed to the side plate **71** between the side plate **71** and the movable plate **73**. The cam **75** is fixed to an output shaft of the rotary actuator **74**. The plurality of springs **76** is fixed to the side plate **71** at one end thereof and is fixed to the movable plate **73** at the other end of the side plate **71**.

The cam **75** is configured to be rotated in one direction by the rotary actuator **74** and to be rotated a predetermined rotational degree. Then, the movable plate **73** is pushed by the cam **75**, and is moved by a predetermined amount of movement in a direction away from the side plate **71**. At this time, the plurality of springs **76** is extended, and increases a restoring force thereof.

The rotary actuator **74** is configured to return to an initial position thereof after the operation of the side registration correction has finished. Then, the movable plate **73** returns to an initial position thereof by the restoring force of the plurality of springs **76**.

As illustrated in FIG. **1** through FIG. **3**, the movable plate **73** rotatably supports a shaft **39***a* and a shaft **38***a* which are shafts of the relay roller pair **39** and the registration roller pair **38** serving as the first sheet conveyance part, and rotatably supports shafts **60***a* of the plurality of conveying roller pairs **60** serving as the second sheet conveyance part.

The movable plate **73** holds a motor **40** which is controlled by the main body controller **90** to rotate. The motor transmits a driving force to the shaft **39***a* and the shaft **38***a* via a gear train **41** and rotates the shafts **39***a* and **38***a*. Similarly, another motor transmits a driving force to the shafts **60***a* of the plurality of conveying roller pairs **60** via another gear train and rotates the shafts **60***a*.

Accordingly, the side registration correcting mechanism **70** is configured to simultaneously move all of the relay roller pairs **39** and the registration roller pairs **38**, which are conveying the sheet S for printing on the second face, and the

plurality of conveying roller pairs **60**, the movement thereof is to be a predetermined amount in a horizontal direction perpendicular to the sheet conveying direction.

By this configuration, the side registration correcting mechanism **70** is able to accurately correspond/align a start position of printing on the second face of the sheet relative to an image printed on the first face of the sheet. The side registration correcting mechanism **70** is configured to return to the initial position thereof after finishing conveying the sheet.

The side position detector **80** (side end detector) including a CIS (Contact Image Sensor) is disposed nearby on a downstream side relative to the registration roller pair **38** in the sheet conveying direction. The main body controller **90** is configured to output a read instruction signal to the side position detector **80** based on a detection signal from the first sensor **81**. The first sensor **81** is disposed at a predetermined position and is configured to detect a position of a rear end of the sheet in the sheet conveying direction. The side position detector **80** is configured to detect a rear end side of a side end of the first face of the sheet S in the sheet conveying direction, and the side end is disposed at a distant side from the movable plate **73**. The side position detector **80** is configured to detect a first side position P**1** which is a distance between the side end and a reference position P**0** in the first face of the sheet S.

The main body controller **90** is configured to output a read instruction signal to the side position detector **80** based on a detection signal from the second sensor **82**. The second sensor **82** is disposed at a predetermined position and is configured to detect a position of a front end of the sheet in the sheet conveying direction. The side position detector **80** is configured to detect a front end side of a side end of the second face of the sheet S in the sheet conveying direction, and the side end is disposed at the distant (opposite) side from the movable plate **73**. The side position detector **80** is configured to detect a second side position P**2** which is a distance between the side end and the reference position P**0** in the second face of the sheet S.

After the sheet S is conveyed in the first face thereof as illustrated in FIG. **1**, the sheet S is conveyed in the second face thereof as illustrated in FIG. **2**. Then, as illustrated in FIG. **3**, the positions of the sheet S in the first and second face are shifted from each other (do not align), because of a mechanical inaccuracy of the conveyance passage, unevenness of a diameter of the plurality of the roller pairs, a slipping at a roller nip, and so on. Consequently, a deviation ΔX between the first side position P**1** and the second side position P**2** is caused.

Further, the position of the first sensor **81** can be adjusted to the downstream side relative to the side position detector **80** in the sheet conveying direction. The position of the second sensor **82** can be adjusted thereof to the upstream side relative to the side position detector **80** in the sheet conveying direction.

The side position memory **97** (side end memory) is configured to store the first side position P**1** and the second side position P**2** of the sheet S which are detected by the side position detector **80**. A rotary encoder attached to the rotary actuator **74** is configured to output a rotation angle from an origin position which is corresponding to the deviation ΔX of the sheet S. Further, the side position memory **97** is configured to store a data table of the rotation angles which are measured by the rotary encoder in advance.

The main body controller **90** is configured to calculate the deviation ΔX of the sheet S based on the first side position P**1** and the second side position P**2** which are stored in the side position memory **97**. The main body controller **90** is configured to set the deviation ΔX as a side registration correction amount of the movable plate **73** of the side registration correcting mechanism **70**.

The main body controller **90** is configured to operate the side registration correcting mechanism **70** to move the first sheet conveyance part **37** and second sheet conveyance part **60** by the side registration correction amount while the first sheet conveyance part **37** is conveying the reversed sheet S.

FIG. **6** is a schematic flowchart of the side registration correcting operation which the main body controller **90** performs based on the program in a duplex printing mode.

The main body controller **90** starts the program, and operates such that each of the pick-up roller **34** and the feed roller pair **35** disposed in the one of sheet hoppers **31**, **32**, **33** selected by a user for use, the plurality of roller pairs **36**, the relay roller pair **39**, and the registration roller pair **38** rotate intermittently by a predetermined time lag.

Consequently, the main body controller **90** performs an operation which is conveying the sheet S from the sheet feeding part **30** to the printing position by controlling these related parts such that they are conveying the sheet S to the printing position (STEP S**1**).

Next, the main body controller **90** inputs a detection signal of the first side position P**1** disposed at a distant side from the movable plate **73**, which is a rear end side of the first face of the sheet S in the sheet conveying direction, by detecting the rear end side of a side end of the first face of the sheet S in the sheet conveying direction with the side position detector **80** when the first sensor **81** inputs a detection signal to the main body controller **90** (STEP S**2**).

Next, the main body controller **90** inputs the detection signal of the first side position P**1** to the side position memory **97** and a detection data of the first side position P**1** is stored in the side position memory **97** (STEP S**3**).

Next, the main body controller **90** controls a plurality of functionally-related parts such that the image forming part **10** forms the layered image including four colors for the first face of the sheet S on the intermediate transfer belt **18**, and the layered image is transferred on the first face of sheet S which is conveyed to the secondary transferring position by the registration roller pair **38** by a secondary transferring, and the transferred image is fixed on the first face of sheet S by the fixing device **46**. Each timing of operations of these functionally-related parts is adjusted to the sheet feeding operation described above (STEP S**4**).

Next, the main body controller **90** controls such that the end portion **51***a* is positioned on an upper side relative to the sheet conveyance surface (virtual surface) of the most upstream one of the plurality of guiding roller pairs **53** in the sheet conveying direction, and the sheet S is conveyed toward the switch back roller pair **52**, and the switch back roller pair **52** stops to rotate before the sheet S passes through the switch back roller pair **52**, and then the switch back roller pair **52** starts to rotate in counter direction.

The main body controller **90** controls such that the reversed sheet S is conveyed to the first sheet conveyance part **37** by the plurality of conveying roller pairs **60** serving as the second sheet conveyance part. Subsequently the sheet S is conveyed by the relay roller pair **39** and the registration roller pair **38** to the printing position.

Consequently, the main body controller **90** performs an operation which is conveying the sheet S from the sheet reversing part **50** to the printing position by controlling these parts (STEP S**5**).

Next, the main body controller **90** inputs a detection signal of the second side position P**2** disposed at a distant side from the movable plate **73**, which is a front end side of the second

face of the sheet S in the sheet conveying direction, by detecting the front end side of a side end of the second face of the sheet S in the sheet conveying direction with the side position detector **80** when the second sensor **82** inputs a detection signal to the main body controller **90** (STEP S**6**).

Next, the main body controller **90** inputs the detection signal of the second side position P**2** to the side position memory **97** and a detection data of the second side position P**2** is stored in the side position memory **97** (STEP S**7**).

Next, the main body controller **90** calculates the deviation ΔX (see FIG. **3**) of the sheet S based on the first side position P**1** and the second side position P**2** which are stored in the side position memory **97**. The main body controller **90** sets the deviation ΔX as a side registration correction amount of the side registration correcting mechanism **70**. The main body controller **90** reads out the rotation angle of the rotary actuator **74** which is corresponding to the deviation ΔX of the sheet S from the data table stored in the side position memory **97**.

The main body controller **90** performs control such that the rotary actuator **74** is only rotated by the rotation angle.

Consequently, the main body controller **90** controls the movement of the side registration correcting mechanism **70** such that the deviation ΔX of the sheet S is eliminated/accounted for by the rotation of the rotary actuator **74**, while each of the first sheet conveyance part (including the relay roller pair **39** and the registration roller pair **38**) and the second sheet conveyance part (including the plurality of conveying roller pairs **60**) only conveys by a deviation ΔY (see FIG. **3**) (STEP S**8**).

Accordingly, the second face of the sheet S is overlapped with the first face of the sheet S by moving diagonally indicated by arrow A in FIG. **3**, and the second side position P**2** is accurately aligned to the first side position P**1**.

Namely, the sheet S is reversed when printing on the second face. With regard to the position detection of the side end of the sheet S, the first side position P**1** is detected at the rear side of the sheet S, and the second side position P**2** is detected at the front side of the sheet S.

Consequently, the main body controller **90** controls the movement of the side registration correcting mechanism **70** such that the rear side of the first side position P**1** corresponds to (aligns with) the front side of the second side position P**2**. Thus, it is possible to accurately align the positions of images on both faces of the sheet S.

As illustrated in the FIG. **3** and FIG. **4**, a former position of the registration roller pair **38**, the relay roller pair **39**, and the plurality of conveying roller pair **60** is drawn by solid line before they are shifted. As illustrated in the FIG. **3**, when the registration roller pair **38**, the relay roller pair **39**, and the plurality of conveying roller pair **60** are shifted by the side registration correcting mechanism **70**, the sheet S is moving diagonally indicated by arrow A, and then, the second side position P**2** accurately corresponds to (aligns with) the first side position P**1**.

Next, the main body controller **90** controls a plurality of functionally-related parts such that the image forming part **10** forms the layered image including four colors for the second face of the sheet S on the intermediate transfer belt **18**, and the layered image is transferred on the second face of sheet S which is conveyed to the secondary transferring position by the registration roller pair **38** by a secondary transferring, and the transferred image is fixed on the second face of sheet S by the fixing device **46**. Each timing of operations of these parts is adjusted to the operation which is conveying the sheet S to a sheet reversing position and the printing position (STEP S**9**).

Next, the main body controller **90** controls the bifurcating claw **51** such that the end portion **51***a* of the bifurcating claw **51** is positioned lower relative to a sheet conveyance surface (virtual surface) of the most upstream one of the plurality of guiding roller pairs **53** in the sheet conveying direction, and controls the ejecting roller pair **54** to rotate. Accordingly, the sheet S is conveyed over the bifurcating claw **51** and toward the ejecting roller pair **54**, and is ejected on the stack tray **55** by the ejecting roller pair **54** (STEP S**10**).

Consequently, the main body controller **90** is configured to repeat STEP S**1** through the STEP S**10** as described above according to the number of printing sheets.

As described above and as illustrated in FIG. **1**, the movable plate **73**, which includes a single plate, rotatably supports the shaft **39***a* and the shaft **38***a* which are shafts of the relay roller pair **39** and the registration roller pair **38** serving as the first sheet conveyance part, and rotatably supports the shafts **60***a* of the plurality of conveying roller pairs **60** serving as the second sheet conveyance part.

Accordingly, the movable plate **73** is large, and a stress of the mechanical structure is large, and thus, a large driving force is needed to move the mechanical structure. To this point, the mechanical structure of the first embodiment can be improved to move the plurality of conveying roller pairs **60** for the side registration correcting operation, even when the sheet S is not held by a plurality of conveying roller pairs **60** because of a length of the sheet S is not so long in the sheet conveying direction.

The first sheet conveyance part **37** and the second sheet conveyance part **60** are independently controlled to rotate by the main body controller **90**. For this reason, it becomes easier to assemble the mechanical structure when the mechanical structure is separated into two parts: one part that supports and moves the shaft **39***a* and the shaft **38***a*, and another part that supports and moves the shafts **60***a*. As a result, it becomes easier to move the movable plate **73**.

Therefore, in the second embodiment of the disclosure as described below, the mechanical part for the side registration correcting operation is separated into a first mechanical part, which relates to the first sheet conveyance part **37**, and a second mechanical part, which relates to the second sheet conveyance part **60**.

In the descriptions of the second embodiment, the same components or components with the same functions as the components of the printer **1** of the first embodiment are denoted by the same reference symbols. The characteristic components of the printer **1**A of the second embodiment, which are different from the components of the printer **1** of the first embodiment, are explained below.

Second Embodiment

Referring to FIG. **7** through FIG. **10**, a printer **1**A according to the second embodiment includes, inside the casing **2**, the image forming part **10**, the sheet feeding part **30**, the first sheet conveyance part **37**, the fixing device **46**, the sheet reversing part **50**, and the second sheet conveyance part **60**.

Further, the printer **1**A includes a plurality of characteristic parts which include a side registration correcting mechanism **70**A serving as a correction mechanism, the side position detector **80** serving as the side end detector, and a main body controller **90**A serving as a controller. The side registration correcting mechanism **70**A is separated upward and downward to the first mechanical part which relates to the first sheet conveyance part **37** and the second mechanical part which relates to the second sheet conveyance part **60**. A detailed explanation is given below.

As illustrated in FIG. **7**, the image forming part **10** includes photoconductors **11**Y, **11**M, **11**C, **11**K serving as the image bearers corresponding to four colors which are disposed along the upper surface of the intermediate transfer belt **18**. Further, the image forming part **10** includes the toner image forming parts **12**, **13**, **14**, **15**, **16** which are forming visible images for each color, the intermediate transfer belt **18** serving as the intermediate transfer medium which transfers the visible images from each of the photoconductors **11**Y, **11**M, **11**C, **11**K, and the secondary transfer roller **25** which transfers the layered image, that is layered four colors of visible images, on the sheet S serving as the recording medium. In the drawings and the descriptions, Y, M, C, and K are symbols appended to components corresponding to yellow, magenta, cyan, and black, respectively, and will be omitted appropriately.

The toner image forming parts **12**, **13**, **14**, **15**, **16** are arranged in the rotational direction of the photoconductor **11** in this order. The toner image forming parts **12**, **13**, **14**, **15**, **16** are, for example explained in the Yellow station representative of other colors, the charging device **12** serving as the charger which takes the charge to the surface of the photoconductor **11**, the laser scanning device **13** serving as the exposing device, the developing device **14**, the cleaning device **15** to clean the remaining toner on the surface of the photoconductor **11** after transferring, and the quenching lamp **16** serving as the neutralizer which neutralizes the charged surface of the photoconductor **11**. The other color stations include the same configuration as the Yellow station. Each of primary transfer rollers **24** pushes the intermediate transfer belt **18** toward each of the photoconductors **11** corresponding to each of primary transfer rollers **24**.

The intermediate transfer belt **18** is seamless and is wound around the first roller **19**, the second roller **20**, the third roller **21**, and the fourth roller **22** serving as the plurality of support members and moves the rollers **19**-**22** around. The cleaning device **23** of the intermediate transfer belt is disposed at the position facing to the second roller **20**. The secondary transfer roller **25**, which is driven, is disposed below the fourth roller **22** and pushes the sheet S toward the intermediate transfer belt **18**.

The belt conveyor **44** is disposed at the downstream side of the secondary transfer roller **25** in the sheet conveying direction. Further the fixing device **46** fixes the visible toner image on the sheet S and is disposed at the downstream side of the belt conveyor **44** in the sheet conveying direction.

Accordingly, each color of the four toner images is formed on each of the surfaces of the photoconductors **11**Y, **11**M, **11**C, **11**K, and the four toner images are transferred on the outer surface of the intermediate transfer belt **18** by the primary transferring. As a result of the primary transferring, the four toner images are layered on the outer surface of the intermediate transfer belt **18**. The layered image including four colors of toner images is transferred on the sheet S by the secondary transferring. After that, the layered image on the sheet S is fixed by heating and pressing of the fixing device **46**. The printing operation of the image forming apparatus is performed in this sequence.

The sheet feeding part **30** includes first, second, third sheet hoppers **31**, **32**, **33** which are vertically disposed at the bottom side of the casing **2**, and includes the plurality of roller pairs **36**, **36**, **36** serving as the vertical sheet conveyor which takes over the sheet S from one of the sheet hoppers upwardly convey the sheet S, and transfer the sheet S to the first sheet conveyance part **37**. Each of the sheet hoppers includes the pick-up roller **34** which picks up the single sheet from the sheet hopper. The sheet S is not limited to plain paper, and may include thick paper, a postcard, an envelope, thin paper, coated paper, art paper, tracing paper, or the like. The sheet S may be an OHP (Over-Head Projector) sheet, an OHP films, or the like. In other words, the sheet S may be any type of recording medium capable of carrying the image thereon.

A user who operates the printer **1**A selects one of sheet hoppers **31**, **32**, **33** which accommodates preferable sheet for user via the main body controller **90** or some input terminal such as a personal computer which is connected to a network and which is constructed in a system. Thereby, the sheet S which is accommodated in the selected one of sheet hoppers **31**, **32**, **33** and is conveyed upwardly to the first sheet conveyance part **37**, which is disposed on the downstream side in the sheet conveying direction.

The image forming position where the layered image on the intermediate transfer belt **18** is transferred to the sheet S is, in other words, the secondary transferring position where the secondary transfer roller **25** and the intermediate transfer belt **18** form the contact nip. The first sheet conveyance part **37** is disposed on the upstream side relative to the secondary transferring position in the sheet conveying direction and is on the virtual surface which extends horizontally from the contact nip. The first sheet conveyance part **37** includes the registration roller pair **38** and the relay roller pair **39** which is disposed on the upstream side relative to the registration roller pair **38** in the sheet conveying direction.

The registration roller pair **38** and the relay roller pair **39** are configured to rotate intermittently, and to sequentially receive the sheet S which is sequentially conveyed from the plurality of roller pairs **36** and to convey along the sheet conveying direction toward the secondary transferring position.

The sheet reversing part **50** includes the plurality of guiding roller pairs **53**, the bifurcating claw **51**, and the switch back roller pair **52**. The plurality of guiding roller pairs **53** is disposed on the downstream side relative to the fixing device **46** in the sheet conveying direction. A pair of the plurality of guiding roller pairs **53** is arranged almost horizontally and the other pair of the plurality of guiding roller pairs **53** is arranged almost vertically downward from the fixing device **46**. The bifurcating claw **51** is disposed at a position just downstream of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction. The switch back roller pair **52** is disposed downwardly relative to the most downward pair of the plurality of guiding roller pairs **53**.

The switch back roller pair **52** is configured to intermittently rotate, corresponding to a conveyance of the sheet S, in one rotational direction and in the other rotational direction. The plurality of guiding roller pairs **53** is configured to rotate intermittently corresponding to the conveyance of the sheet S.

The bifurcating claw **51** is formed in the wedge-shape by the upper inclined surface and the lower inclined surface thereof. The end portion **51***a* which is the tip portion of the wedge-shape faces the upstream side in the sheet conveying direction. The bifurcating claw **51** is configured to move the end portion **51***a* up and down by the actuator. In the simplex printing mode, the end portion **51***a* of the bifurcating claw **51** is moved down by the actuator. Then, the end portion **51***a* is positioned below/lower relative to a sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction.

Accordingly, the sheet S is conveyed over the upper inclined surface of the bifurcating claw **51** and toward to the plurality of guiding roller pairs **53** and the ejecting roller pair **54** at the downstream in the sheet conveying direction. The sheet S is ejected on the stack tray **55** by the ejecting roller pair **54**.

Meanwhile, in the duplex printing mode, the end portion **51***a* is positioned higher relative to the sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction until printing the first face of the duplex printing is finished. The end portion **51***a* is positioned below/lower relative to the sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction until printing the second face of the duplex printing is finished.

Accordingly, after printing the first face of the duplex printing, the sheet S is conveyed under the lower inclined surface of the bifurcating claw **51** and toward the switch back roller pair **52**. Before the sheet S passes through the switch back roller pair **52**, the switch back roller pair **52** stops rotating, and then, the switch back roller pair **52** starts rotating in the counter direction. Consequently, the sheet S (which is upside down) is conveyed horizontally toward the second sheet conveyance part **60**. Further, after printing the second face of the duplex printing, in the same manner as the simplex printing mode, the end portion **51***a* is positioned below/lower relative to the sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction.

The second sheet conveyance part **60** includes the plurality of conveying roller pairs (hereinafter, referred to as "the conveying roller pair **60**") which is arranged along the sheet conveyance surface parallel to the sheet conveyance surface formed at the contact nip of secondary transferring, which is disposed lower than the contact nip, and which is configured to rotate intermittently.

The plurality of conveying roller pairs **60** receives the sheet S which is reversed from the switch back roller pair **52** and conveys so as to pass the sheet S to the first sheet conveyance part **37**, which includes the registration roller pair **38** and the relay roller pair **39**.

Consequently, in the simplex printing mode, the sheet S in the selected one of sheet hoppers **31**, **32**, **33** is picked up by the pick-up roller **34** and the feed roller pair **35** and is conveyed upwardly by the plurality of roller pairs **36**.

Subsequently, the sheet S is conveyed by the relay roller pair **39** and the registration roller pair **38** toward the contact nip and is pressed by the secondary transfer roller **25** at the contact nip with the intermediate transfer belt **18** and transfers the layered image (including four colors of toner images) on the intermediate transfer belt **18** by the secondary transferring. After that, the layered image on the sheet S is fixed by the fixing device **46** and the sheet S is ejected on the stack tray **55**.

Meanwhile, in the duplex printing mode, in the same manner as the simplex printing mode, at first, the sheet S is printed on the first face (see FIG. **7**). After that, the sheet S is reversed by the sheet reversing part **50** and is subsequently conveyed by the plurality of conveying roller pairs **60**. Next, the sheet S is subsequently conveyed by the first sheet conveyance part **37**, which includes the relay roller pair **39** and the registration roller pair **38** (see FIG. **8**).

Further after that, similar to the simplex printing mode described above, the second face of the duplex printing that includes the layered image (including four colors of toner images) is transferred on the intermediate transfer belt **18** by the secondary transferring. After that, the layered image on the second face is fixed by the fixing device **46** and the sheet S is ejected on the stack tray **55**.

FIG. **11** is a block diagram of the main body controller **90**A of the printer **1**A, and FIG. **12** is a block diagram of the overall printer **1**A. The main body controller **90**A serves as a controller in the present disclosure.

As illustrated in FIG. **11**, the main body controller **90**A includes the CPU **91** (Central Processing Unit), the ROM **92** (Read Only Memory) which stores the fixed data, the RAM **93** (Random Access Memory) which stores the temporary data, the INPUT interface **95**, and the OUTPUT interface **96**.

The ROM **92** stores programs for which the CPU **91** performs operations. The RAM **93** functions as the work area which is used by the CPU **91** when the CPU **91** performs operations. The main body controller **90**A can include communication capabilities. The main body controller **90**A is configured to control all operations in the printer **1**A.

For example, the ROM **92**, serving as the memory, stores the program that is used for controlling the printer **1**A including the side registration correcting operation in the second embodiment. The CPU **91** is configured to perform the arithmetic processing based on the program which is stored in the ROM **92**. The RAM **93** is configured to temporary store the result of the arithmetic processing of the CPU **91**, the data which is inputted from the operating part **84** (described later), etc.

The CPU **91**, the ROM **92**, and the RAM **93** are connected with each other via the bus **94** and are connected with the INPUT interface **95** and the OUTPUT interface **96**.

In FIG. **10** and FIG. **12**, the main body controller **90**A (in particular, the INPUT interface **95**) is connected with the side position detector **80** (side end detector), the first sensor **81**, the second sensor **82**, the operating part **84**, other sensors **98**, and the outer peripheral communicating device **99**. The INPUT interface **95** is input detection signals and instruction signals from the devices with which it is connected.

Further, the main body controller **90**A (in particular, the OUTPUT interface **96**) is connected with each of the object parts that are the image forming part **10**, the fixing device **46**, the sheet feeding part **30** which includes first, second, third feeding hoppers **31**, **32**, **33**, the roller pair **36**, the first sheet conveyance part **37**, the sheet reversing part **50**, the ejecting roller pair **54**, the second sheet conveyance part **60**, the side registration correcting mechanism **70**A, and the side position memory **97** (side end memory). Further, the OUTPUT interface **96** is connected with the panel display **83**.

The side position memory **97** is also connected with the INPUT interface **95**. The main body controller **90**A is configured to perform the arithmetic processing based on the detection signals which are input via the INPUT interface **95**, and is configured to perform various operations, which correspond to each of the object parts, via the OUTPUT interface **96**.

The side position memory **97** includes the nonvolatile memory and is configured to store position data which includes the position P**1** of side end of sheet in first face and the position P**2** of side end of sheet in second face. The side position memory **97** can be included in the main body controller **90**A.

In the second embodiment, as illustrated in FIG. **7**, the input display device **85** is disposed above the casing **2** of printer **1**A. The input display device **85** includes the panel display **83**, the operating part **84**, the main body controller **90**A, and the side position memory **97**, all together.

In the second embodiment, the side registration correction in the duplex printing mode is performed. The side registration correction in the second embodiment is described later by referring to FIG. **7** through FIG. **13**.

The meaning of "the side registration correction" is to correct relative positions of images formed on both faces of the sheet S in the duplex printing mode. In other words, the meaning of "the side registration correction" is to reduce the position difference between the image formed on the first face

of the sheet S and the image formed on the second face of the sheet S. In the case that the position difference of the relative positions of images is lower, the position accuracy (two side accuracy) of the relative positions of images is higher. The side registration correction is to be performed only in the duplex printing mode, and not to be performed in the simplex printing mode.

FIG. **9** is a schematic plan view of the side registration correcting mechanism **70**A of the printer **1**A and includes a block diagram that is the main body controller **90**A and performs an operation of the side registration correction on the first face of the duplex printing mode.

FIG. **10** is a schematic plan view of the side registration correcting mechanism **70**A of the printer **1**A and includes a block diagram that is the main body controller **90**A and performs the operation of the side registration correction on the second face of the duplex printing mode.

The side registration correction of the printer **1**A in the second embodiment is configured to work by a cooperation of the side registration correcting mechanism **70**A, the side position detector **80** (side end detector), the first sensor **81**, the second sensor **82**, and the main body controller **90**A.

As illustrated in FIG. **9** and FIG. **10**, the side registration correcting mechanism **70**A includes the side plate **71**, which is formed in a vertical face shape along the sheet conveyance passage, which is fixed on the side of the sheet conveyance passage where printing is performed, and which is disposed inside of the casing **2**.

The side registration correcting mechanism **70**A includes the plurality of guide **72** and movable plates **73**A, **73**B which are separated into an upper portion and a lower portion. Specifically, the movable plates **73**A, **73**B include a first movable plate **73**A (first plate) and a second movable plate **73**B (second plate). The plurality of guides **72** are configured to guide each of the movable plates **73**A, **73**B such that both of the movable plates **73**A, **73**B are parallel to the side plate **71** between the side plate **71** and the sheet conveyance passage. The plurality of guide **72** are fixed to the side plate **71** at one end thereof, and the other end thereof protrude to a direction perpendicular to the sheet conveying direction.

Further, the side registration correcting mechanism **70**A includes a rotary actuator **74**A, a cam **75**A (eccentricity cam), and a plurality of springs **76**A. The rotary actuator **74**A is fixed to the side plate **71** between the side plate **71** and the first movable plate **73**A which is the upper plate of the movable plates **73**A, **73**B. The cam **75**A is fixed to an output shaft of the rotary actuator **74**A. The plurality of springs **76**A is fixed to the side plate **71** at one end thereof and is fixed to the first movable plate **73**A at the other end thereof.

The side registration correcting mechanism **70**B includes a rotary actuator **74**B, a cam **75**B (eccentricity cam), and a plurality of springs **76**B. The rotary actuator **74**B is fixed to the side plate **71** between the side plate **71** and the second movable plate **73**B which is the lower plate of the movable plates **73**A, **73**B. The cam **75**B is fixed to an output shaft of the rotary actuator **74**B. The plurality of springs **76**B is fixed to the side plate **71** at one end thereof and is fixed to the second movable plate **73**B at the other end thereof.

Each of the cams **75**A, **75**B is configured to be rotated in one direction by the respective rotary actuator **74**A, **74**B which are synchronously controlled by the main body controller **90**A and be rotated by a predetermined rotational degree. Then, the movable plates **73**A, **73**B are pushed by the cams **75**A, **75**B, and are moved by a predetermined amount of movement in a direction away from the side plate **71**.

At this time, the plurality of springs **76**A, **76**B are extended, and increase a restoring force thereof. The rotary actuators **74**A, **74**B are configured to return to initial positions thereof after the operation of the side registration correction has finished. Then, the movable plates **73**A, **73**B return to the initial positions thereof by the restoring force of the plurality of springs **76**A, **76**B.

In addition, in a case that a length of the sheet S is shorter in the sheet conveying direction than a length that is of sufficient length to be held by the plurality of conveying roller pairs **60** when the main body controller **90**A performs the operation of the side registration correction, it is possible not to drive the rotary actuator **74**B which is a the lower actuator of the rotary actuators **74**A, **74**B.

As illustrated in FIG. **7** and FIG. **9**, the first movable plate **73**A rotatably supports a shaft **39***a* and a shaft **38***a* which are shafts of the relay roller pair **39** and the registration roller pair **38** serving as the first sheet conveyance part. The first movable plate **73**A holds a motor **40**A which is controlled to rotate by the main body controller **90**A. The motor **40**A transmits a driving force to the shaft **39***a* and the shaft **38***a* via a gear train **41**A and rotates them.

As illustrated in FIG. **7** and FIG. **10**, the second movable plate **73**B rotatably supports the shafts **60***a* of the plurality of conveying roller pairs **60** serving as the second sheet conveyance part. The second movable plate **73**B holds a motor **40**B which is controlled to rotate by the main body controller **90**A. The motor **40**B transmits a driving force to the shafts **60***a* via a gear train **41**B and rotates them.

Accordingly, the side registration correcting mechanism **70**A is configured to simultaneously move all of the relay roller pair **39** and the registration roller pair **38**, which are conveying the sheet S for printing on the second face, and the plurality of conveying roller pairs **60**, a predetermined amount in a horizontal direction perpendicular to the sheet conveying direction.

By this configuration, the side registration correcting mechanism **70**A accurately aligns a start position of printing on the second face of the sheet S relative to an image printed on the first face of the sheet S. The side registration correcting mechanism **70**A is configured to return to the initial position thereof after finishing conveying the sheet.

The side position detector **80** (side end detector) including the CIS (Contact Image Sensor) is disposed near/adjacent, on a downstream side, relative to the registration roller pair **38** in the sheet conveying direction. The main body controller **90**A is configured to output a read instruction signal to the side position detector **80** based on a detection signal from the first sensor **81**. The first sensor **81** is disposed at a predetermined position and is configured to detect a position of a rear end of the sheet S in the sheet conveying direction. The side position detector **80** is configured to detect a rear end side of a side end of the first face of the sheet S in the sheet conveying direction, and the side end is disposed at a distant side from the first movable plate **73**A. The side position detector **80** is configured to detect a first side position P**1** which is a distance between the side end and a reference position P**0** in the first face of the sheet S.

The main body controller **90**A is configured to output a read instruction signal to the side position detector **80** based on a detection signal from the second sensor **82**. The second sensor **82** is disposed at a predetermined position and is configured to detect a position of a front end of the sheet in the sheet conveying direction. The side position detector **80** is configured to detect a front end side of a side end of the second face of the sheet S in the sheet conveying direction, and the side end is disposed at the distant side from the first movable plate **73**A. The side position detector **80** is configured to

detect a second side position P2 which is a distance between the side end and the reference position P0 in the second face of the sheet S.

After the sheet S is conveyed in the first face thereof as illustrated in FIG. **7**, the sheet S is conveyed in the second face thereof as illustrated in FIG. **8**. Then, as illustrated in FIG. **9**, the positions of the sheet S in the first and second face are shifted from each other (do not align), because of a mechanical inaccuracy of the conveyance passage, unevenness of a diameter of the plurality of the roller pairs, a slipping at a roller nip, and so on. Consequently, a deviation ΔX between the first side position P1 and the second side position P2 is caused.

Further, the position of the first sensor **81** can be adjusted to the downstream side relative to the side position detector **80** in the sheet conveying direction. The position of the second sensor **82** can be adjusted to the upstream side relative to the side position detector **80** in the sheet conveying direction.

The side position memory **97** (side end memory) is configured to store the first side position P1 and the second side position P2 of the sheet S which are detected by the side position detector **80**. A rotary encoder attached to the rotary actuator **74** is configured to output a rotation angle from an origin position which is corresponding to the deviation ΔX of the sheet S. Further, the side position memory **97** is configured to store a data table of the rotation angles which are measured by the rotary encoder in advance.

The main body controller **90**A is configured to calculate the deviation ΔX of the sheet S based on the first side position P1 and the second side position P2 which are stored in the side position memory **97**. The main body controller **90**A is configured to set the deviation ΔX as side registration correction amounts of the movable plates **73**A, **73**B of the side registration correcting mechanism **70**A.

The main body controller **90**A is configured to operate the side registration correcting mechanism **70**A to move the first sheet conveyance part **37** and second sheet conveyance part **60** by the side registration correction amount while the first sheet conveyance part **37** is conveying the reversed sheet S.

FIG. **13** is a schematic flowchart of the side registration correcting operation which the main body controller **90**A performs based on the program in a duplex printing mode.

The main body controller **90**A starts the program and operates such that the pick-up roller **34** and the feed roller pair **35** disposed in the one of sheet hoppers **31**, **32**, **33** selected by a user for use, the plurality of roller pairs **36**, the relay roller pair **39**, and the registration roller pair **38** rotate intermittently by a predetermined time lag between each of them.

Consequently, the main body controller **90**A performs an operation which is conveying the sheet S from the sheet feeding part **30** to the printing position by controlling these related operations such that they are conveying the sheet S to the printing position (STEP S**11**).

Next, the main body controller **90**A inputs a detection signal of the first side position P1 disposed at a distant side from the first movable plate **73**A, which is a rear end side of the first face of the sheet S in the sheet conveying direction, by detecting the rear end side of a side end of the first face of the sheet S in the sheet conveying direction with the side position detector **80** when the first sensor **81** inputs a detection signal to the main body controller **90**A (STEP S**12**).

Next, the main body controller **90**A inputs the detection signal of the first side position P1 to the side position memory **97** and a detection signal of the first side position P1 is stored in the side position memory **97** (STEP S**13**).

Next, the main body controller **90**A controls a plurality of functionally-related parts such that the image forming part **10** forms the layered image including four colors for the first face of the sheet S on the intermediate transfer belt **18**, and the layered image is transferred on the first face of sheet S which is conveyed to the secondary transferring position by the registration roller pair **38** by a secondary transferring, and the transferred image is fixed on the first face of sheet S by the fixing device **46**. Each timing of operations of these functionally-related parts is adjusted to the sheet feeding operation described above (STEP S**14**).

Next, the main body controller **90**A controls such that the end portion **51***a* is positioned on an upper side relative to the sheet conveyance surface (virtual surface) of the most upstream one of the plurality of guiding roller pairs **53** in the sheet conveying direction, and the sheet S is conveyed toward the switch back roller pair **52**, and the switch back roller pair **52** stops rotating before the sheet S passes through the switch back roller pair **52**, and the switch back roller pair **52** starts to rotate in counter direction.

The main body controller **90**A controls such that the reversed sheet S is conveyed to the first sheet conveyance part **37** by the plurality of conveying roller pairs **60** serving as the second sheet conveyance part that is driven by the motor **40**B. Subsequently the sheet S is conveyed to the printing position by the relay roller pair **39** and the registration roller pair **38** that are driven by the motor **40**A.

Consequently, the main body controller **90**A performs an operation conveying the sheet S from the sheet reversing part **50** to the printing position by controlling these related operations/parts (STEP S**15**).

Next, the main body controller **90**A inputs a detection signal of the second side position P2 disposed at a distant side from the first movable plate **73**A, which is a front end side of the second face of the sheet S in the sheet conveying direction, by detecting the front end side of a side end of the second face of the sheet S in the sheet conveying direction with the side position detector **80** when the second sensor **82** inputs a detection signal to the main body controller **90**A (STEP S**16**).

Next, the main body controller **90**A inputs the detection signal of the second side position P2 to the side position memory **97** and a detection signal of the second side position P2 is stored in the side position memory **97** (STEP S**17**).

Next, the main body controller **90**A calculates the deviation ΔX (see FIG. **10**) of the sheet S based on the first side position P1 and the second side position P2 which are stored in the side position memory **97**. The main body controller **90**A sets the deviation ΔX as a side registration correction amount of the side registration correcting mechanism **70**A. The main body controller **90**A read out the rotation angle of the rotary actuator **74** which corresponds to the deviation ΔX of the sheet S from the data table stored in the side position memory **97**.

The main body controller **90**A controls the rotary actuator **74** to only rotate by the rotation angle.

Consequently, the main body controller **90**A controls the movement of the side registration correcting mechanism **70**A such that the deviation ΔX of the sheet S is eliminated by the rotation of the rotary actuator **74**, while each of the first sheet conveyance part (including the relay roller pair **39** and the registration roller pair **38**) and the second sheet conveyance part (including the plurality of conveying roller pairs **60**) only conveys by a deviation ΔY (see FIG. **10**) (STEP S**18**).

Accordingly, the second face of the sheet S overlaps the first face of the sheet S by moving diagonally in the direction indicated by arrow A in FIG. **10**, and the second side position P2 is accurately aligned to the first side position P1.

Namely, the sheet S is reversed when printing on the second face. With regard to the position detection of the side end

of the sheet S, the first side position P1 is detected at the rear side of the sheet S, and the second side position P2 is detected at the front side of the sheet S.

Consequently, the main body controller **90**A controls the movement of the side registration correcting mechanism **70**A such that the rear side of the first side position P1 corresponds to the front side of the second side position P2. Thus, it is possible to accurately align the positions of images on both of faces of the sheet S.

As illustrated in FIG. **9** and FIG. **10**, a former position of the registration roller pair **38**, the relay roller pair **39**, and the plurality of conveying roller pairs **60** is drawn by a solid line before they are shifted. As illustrated in FIG. **9**, when the registration roller pair **38**, the relay roller pair **39**, and the plurality of conveying roller pairs **60** are shifted by the side registration correcting mechanism **70**A, the sheet S is moved diagonally as indicated by arrow A, and then, the second side position P2 is accurately aligned with the first side position P1 (shown by the broken line).

Next, the main body controller **90**A controls a plurality of functionally-related parts such that the image forming part **10** forms the layered image including four colors for the second face of the sheet S on the intermediate transfer belt **18**, and the layered image is transferred on the second face of sheet S which is conveyed to the secondary transferring position by the registration roller pair **38** by a secondary transferring, and the transferred image is fixed on the second face of sheet S by the fixing device **46**. Each timing of operations of these functionally-related parts is adjusted to the operation which is conveying the sheet S to a sheet reversing position and the printing position (STEP S**19**).

Next, the main body controller **90**A controls the bifurcating claw **51** such that the end portion **51***a* of the bifurcating claw **51** is positioned lower relative to a sheet conveyance surface (virtual surface) of the most upstream pair of the plurality of guiding roller pairs **53** in the sheet conveying direction, and controls the ejecting roller pair **54** to rotate. Accordingly, the sheet S is conveyed over the bifurcating claw **51** and toward the ejecting roller pair **54**, and is ejected on the stack tray **55** by the ejecting roller pair **54** (STEP S**20**).

Consequently, the main body controller **90**A is configured to repeat STEP S**11** through the STEP S**20** as described above according to the numbers of printings.

In the first and second embodiments s described above, the printer **1**, **1**A, which includes a duplex printing mode, includes the side registration correcting mechanism **70**, **70**A, which is configured to move the first sheet conveyance part **37** conveying a reversed sheet S and the second sheet conveyance part **60** in the direction perpendicular to the sheet conveying direction, and which is configured to return to the original position. Further, the printer **1**, **1**A includes the side position detector **80**, the side position memory **97** which includes the nonvolatile memory and is configured to store the position data of the side end of the sheet S, and the main body controller **90**, **90**A, and the printer **1**, **1**A is configured to work by the cooperation of these parts.

In the first and second embodiments, the printer **1**, **1**A is configured to perform the side registration correction in the duplex printing mode, and to accurately correct relative positions of images formed on both faces of a sheet S such that the position of an image formed on the first face of the sheet S is aligned/corresponds to the position of an image formed on the second face of the sheet S.

In the first and second embodiments, these configurations and these operations of the printer **1**, **1**A as described above, enable to accurate correction of the relative positions of the images formed on the both face of the sheet S, even when the printer **1**, **1**A is a printer that has a smaller distance of the sheet conveyance passage between the feeding roller and the transfer roller and is compact with regard to the width of the machine.

Additional Embodiment(s)

The appended claims are not to be limited to the embodiments described herein, but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fall within the scope set forth herein.

According to the printer **1**, **1**A in the first and second embodiments, the side registration correcting mechanism **70**, **70**A is configured to be able to shift a large sheet. By contrast, when the printer **1**, **1**A is configured to print on both sides of a small sheet, it is possible to construct a side registration correcting mechanism such that the side registration correcting mechanism is configured to shift only the registration roller pair **38** in the duplex printing mode.

According to the configuration described above, for detecting the rear end side of the side end of the first face of the sheet S and the front end side of the side end of the second face in the sheet conveying direction by the side position detector **80**, the detection signals input by the first sensor **81** and the second sensor **82** to the main body controller **90**A, are output as read signals to the side position detector **80**. Note that it is possible to use a single sensor both as the first sensor **81** and the second sensor **82**. Further, according to the configuration described above, the first sensor is configured to detect the rear end side (upstream side) of the side end of the first face of the sheet S in the sheet conveying direction. However, the present disclosure is not limited in this configuration. It is possible to change the first sensor such that the first sensor detects another part of the side end of the first face of the sheet S in the sheet conveying direction.

Moreover, a user can use several optional devices to connect to the printer. For example, a sheet bank which is configured to store a large amount of the sheet and to be able to feed a large amount of sheets; a finisher device which is configured to be able to bind the sheets with staple and fold, and which is substituting for the stack tray **55**; and a scanner and ADF (Auto Document Feeder) which may be disposed at an upper portion of the printer can be connected to the printer. Further, it is possible to provide only one color of image forming station in the printer.

The present disclosure is generally useful for an image forming apparatus and an image forming system which includes a duplex printing mode. Embodiments of the disclosure are able to accurately correct relative positions of images formed on both faces of a sheet, even when the printer including the duplex printing mode is compact (for example, with respect to the width of the machine).

REFERENCE LIST

1, **1**A PRINTER (IMAGE FORMING APPARATUS)
10 IMAGE FORMING PART/IMAGE FORMER
30 SHEET FEEDING PART/SHEET FEEDER
37 FIRST SHEET CONVEYANCE PART/FIRST SHEET CONVEYOR
38 REGISTRATION ROLLER PAIR
50 SHEET REVERSING PART/SHEET REVERSER
60 SECOND SHEET CONVEYANCE PART/SECOND SHEET CONVEYOR
70, **70**A SIDE REGISTRATION CORRECTING MECHANISM (CORRECTION MECHANISM)

80 SIDE POSITION DETECTOR (SIDE END DETECTOR)
90, 90A MAIN BODY CONTROLLER (CONTROLLER)
97 SIDE POSITION MEMORY (SIDE END MEMORY)
P1 FIRST SIDE POSITION (SIDE POSITION OF FIRST FACE OF SHEET)
P2 SECOND SIDE POSITION (SIDE POSITION OF SECOND FACE OF SHEET)
S SHEET
Y SHEET CONVEYING DIRECTION
ΔX DEVIATION

What is claimed is:

1. An image forming apparatus comprising:
a sheet feeder, including a roller, to feed a sheet to a sheet conveyance passage;
an image former, including a transfer belt, to form an image on the sheet;
a first sheet conveyor, including a registration roller, at an upstream side of an image forming position in which the image former forms the image on the sheet, to convey the sheet along a sheet conveying direction;
a sheet reverser, including a guiding roller, to reverse the sheet on which the image is formed on a first face;
a second sheet conveyor, including a conveying roller, to convey the sheet, which is reversed by the sheet reverser, to the first sheet conveyor for the image former to form the image on a second face;
a first sensor to detect a rear end of the sheet in the sheet conveying direction;
a second sensor to detect a front end of the sheet in the sheet conveying direction;
a side end detector disposed near the first sheet conveyor to detect a first rear end side position of the first face when the first sensor detects the rear end of the sheet and to detect a second front end side position of the second face when the second sensor detects the front end of the sheet;
a memory to store the first rear end side position and the second front end side position detected by the side end detector;
a correction mechanism, including a movable plate, to movably support at least the registration roller of the first sheet conveyor and the second sheet conveyor in a direction perpendicular to the sheet conveying direction; and
a controller to calculate a deviation between the first read end side position and the second front end side position, and to set the deviation as a correction amount of the correction mechanism,
wherein, in a side registration correcting operation, the controller controls movement of the correction mechanism by the correction amount.

2. The image forming apparatus according claim 1, wherein the correction mechanism includes
the movable plate, which rotatably supports the registration roller,
a cam to move the movable plate in the direction perpendicular to the sheet conveying direction, and
an actuator to drive the cam,
wherein the actuator is controlled by the controller.

3. The image forming apparatus according claim 2, wherein the cam is an eccentric cam.

4. The image forming apparatus according claim 3, wherein
the actuator is a rotary actuator,
the memory stores a data table that includes a correspondence between a rotation angle of the rotary actuator and the deviation of the sheet, and
in the side registration correcting operation, the controller controls the rotary actuator to rotate by the rotation angle.

5. The image forming apparatus according claim 2, wherein the correction mechanism includes a spring attached to the movable plate at one end thereof.

6. The image forming apparatus according claim 2, wherein the movable plate includes a single plate that rotatably supports the first sheet conveyor and the second sheet conveyor.

7. The image forming apparatus according claim 2, wherein the movable plate includes a first movable plate and a second movable plate, the first movable plate rotatably supports the first sheet conveyor, and the second movable plate rotatably supports the second sheet conveyor.

8. The image forming apparatus according claim 7, wherein each of the first movable plate and the second movable plate is associated with a cam and an actuator.

9. The image forming apparatus according claim 8, wherein when a length of the sheet, in the sheet conveying direction, is shorter than a length of the sheet conveyance passage between the image forming position and a roller that is a most downstream roller of the second sheet conveyor, the controller controls the actuator associated with the first movable plate in the side registration correcting operation.

10. The image forming apparatus according claim 8, wherein when a length of the sheet, in the sheet conveying direction, is longer than a length of the sheet conveyance passage between the image forming position and a roller that is a most downstream roller of the second sheet conveyor, the controller controls the actuators associated with the first movable plate and the second movable plate in the side registration correcting operation.

11. The image forming apparatus according claim 2, wherein the side end detector is disposed on a side opposite the movable plate across the sheet conveyance passage in the direction perpendicular to the sheet conveying direction.

12. The image forming apparatus according claim 1, wherein the side end detector includes a contact image sensor.

13. The image forming apparatus according claim 1, wherein the controller performs the side registration correcting operation when the registration roller is conveying the reversed sheet.

14. An image forming system comprising:
an image forming apparatus to form an image on a sheet; and
a sheet bank to store a plurality of sheets, and to feed the plurality of sheets to the image forming apparatus, wherein the image forming apparatus includes
a sheet feeder, including a roller, to feed the sheet to a sheet conveyance passage,
an image former, including a transfer belt, to form an image on the sheet,
a first sheet conveyor, including a registration roller, at an upstream side of an image forming position in which the image former forms the image on the sheet, to convey the sheet along a sheet conveying direction,
a sheet reverser, including a guiding roller, to reverse the sheet on which the image is formed on a first face,
a second sheet conveyor, including a conveying roller, to convey the sheet, which is reversed by the sheet reverser, to the first sheet conveyor for the image former to form the image on a second face;
a first sensor to detect a rear end of the sheet in the sheet conveying direction;
a second sensor to detect a front end of the sheet in the sheet conveying direction;

a side end detector disposed near the first sheet conveyor to detect a first rear end side position of the first face when the first sensor detects the rear end of the sheet and to detect a second front end side position of the second face when the second sensor detects the front end of the sheet;

a memory to store the first rear end side position and the second front end side position detected by the side end detector;

a correction mechanism, including a movable plate, to movably support at least the registration roller of the first sheet conveyor and the second sheet conveyor in a direction perpendicular to the sheet conveying direction; and

a controller to calculate a deviation between the first read end side position and the second front end side position, and to set the deviation as a correction amount of the correction mechanism,

wherein, in a side registration correcting operation, the controller controls movement of the correction mechanism by the correction amount.

15. An image forming system comprising:

an image forming apparatus to form an image on a sheet; and

a finisher device to bind the sheet, which is conveyed from the image forming apparatus, with staple and fold,

wherein the image forming apparatus includes

a sheet feeder, including a roller, to feed the sheet to a sheet conveyance passage,

an image former, including a transfer belt, to form an image on the sheet,

a first sheet conveyor, including a registration roller, at an upstream side of an image forming position in which the image former forms the image on the sheet, to convey the sheet along a sheet conveying direction,

a sheet reverser, including a guiding roller, to reverse the sheet on which the image is formed on a first face, a second sheet conveyor, including a conveying

roller, to convey the sheet, which is reversed by the sheet reverser, to the first sheet conveyor,

a second sheet conveyor, including a conveying roller, to convey the sheet, which is reversed by the sheet reverser, to the first sheet conveyor for the image former to form the image on a second face;

a first sensor to detect a rear end of the sheet in the sheet conveying direction;

a second sensor to detect a front end of the sheet in the sheet conveying direction;

a side end detector disposed near the first sheet conveyor to detect a first rear end side position of the first face when the first sensor detects the rear end of the sheet and to detect a second front end side position of the second face when the second sensor detects the front end of the sheet;

a memory to store the first rear end side position and the second front end side position detected by the side end detector;

a correction mechanism, including a movable plate, to movably support at least the registration roller of the first sheet conveyor and the second sheet conveyor in a direction perpendicular to the sheet conveying direction; and

a controller to calculate a deviation between the first read end side position and the second front end side position, and to set the deviation as a correction amount of the correction mechanism,

wherein, in a side registration correcting operation, the controller controls movement of the correction mechanism by the correction amount.

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